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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 909

Contribution from the Forest Service
WILLIAM B. GREELEY, Forester

Washington, D. C. PROFESSIONAL PAPER January 17, 1921

UTILIZATION OF BLACK WALNUT

By

WARREN D. BRUSH, Scientific Assistant

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INTRODUCTION.

The use of American black-walnut timber for various products began in early colonial times. Probably its first extensive use was for fence rails, for which it was chosen because it was easy to split and resisted decay. Much of it was cut for fuel. Large quantities of black walnut, which prefers rich agricultural land, were wasted in clearing for cultivation. In the eighteenth century it was a favorite wood for furniture, and was one of the two native woods (wild cherry being the other) best adapted for fine cabinetwork. It was also highly valued for gunstocks. The excellent stands in the fertile valleys of eastern Pennsylvania, which furnished wood of a rich dark color that was well liked, were the main source of supplies.

During the first half of the nineteenth century there was a gradual increase in the use of walnut, which was manufactured mainly into furniture in eastern factories. In this period the region of the Ohio River basin became the chief source of supply.

From 1860 to 1880 the demand for walnut grew tremendously, because of its use for rifle stocks during the Civil War, and also because of its popularity for making furniture. The maximum walnut production was reached about 1875, when it is estimated that the

total cut was approximately 125,000,000 board feet. During this period a large part of the walnut timber was removed from the region east of the Mississippi River.

The past six years have seen a revival in the walnut-furniture industry, and large amounts of the wood have been called for. The greatest use of this timber recently, however, has been for rifle stocks and airplane propellers for the Great War. On account of the unprecedented demand for walnut for these uses, the sawmill cut in 1918 was about 100,000,000 board feet. The entire country was searched for available material, and even small and defective trees that had been considered unfit for lumber were taken.

Walnut has never been plentiful in the sense that large amounts of the timber were available in any one locality. Its scattered growth is the reason for this. The exhaustion of the available supply has been repeatedly announced. Nevertheless, during the war large supplies were discovered that no one thought existed, and many lots of large-sized trees were found that were equal in quality to those of the period when walnut was most popular. The annual cut of walnut timber is comparatively small, but a fairly steady supply is available because of the wide distribution of the tree.

Black walnut (*Juglans nigra* Linn.) is a very near relative of the Circassian walnut (*J. regia* Linn.) of the Old World, which is highly prized as a cabinet wood. It is also closely related to the butternut (*J. cinerea* Linn.) of eastern United States. This last wood is less valuable, however, than the black walnut. There are two other walnuts native to the United States. These are the Mexican walnut (*J. rupestris* Engelm.) and California walnut (*J. californica* Wats.). These two species grow in southwestern United States. The timber is of little importance even locally, and the trees are usually less than 12 inches in diameter, with a clear length of trunk ordinarily not more than 8 to 10 feet.

This bulletin deals with the characteristics, properties, uses, manufacture, and market values of black-walnut wood, and particularly discusses the uses for which walnut is best adapted.

PROPERTIES OF THE WOOD.

GENERAL APPEARANCE.

The heartwood of black walnut is light brown to dark brown or chocolate-brown. The sapwood is nearly white. In forest-grown trees the heartwood is generally a rich chocolate-brown. The sapwood is narrow in such trees, usually 1 inch wide or less. In open-growth trees the heartwood is lighter in color; the sapwood grows to about 3 inches in width, and is white or discolored to yellowish or

purplish brown. The annual rings of growth are usually broad and are marked off from each other by the presence of many pores at the beginning and a somewhat dense growth at the end of each annual ring, as well as by a fine light-colored line between adjacent rings. This contrast between the growth rings is especially marked on tangential cuts and gives a somewhat coarse figure to the wood. The pores are compartively large and in cross sections easily visible to the naked eye; they appear as fine dark and generally short lines over the entire longitudinal surface. Figured wood is in demand for different kinds of finish. Its handsome effect is often produced by dark-colored streaks or alternate stripes of lighter and darker shades. The striped figure in quartered stock is caused by the alternate light and dark shades of the growth rings. Another kind of figure is that formed by the wavy or curly grain which is found near a knot or other defect. Abnormal or irregular growths, crooks, forks, and twists produce a special figure in the wood. Highly figured walnut, with a great variety of design, is cut from the walnut burl—an abnormal growth of wood tissue.

PHYSICAL AND MECHANICAL PROPERTIES.

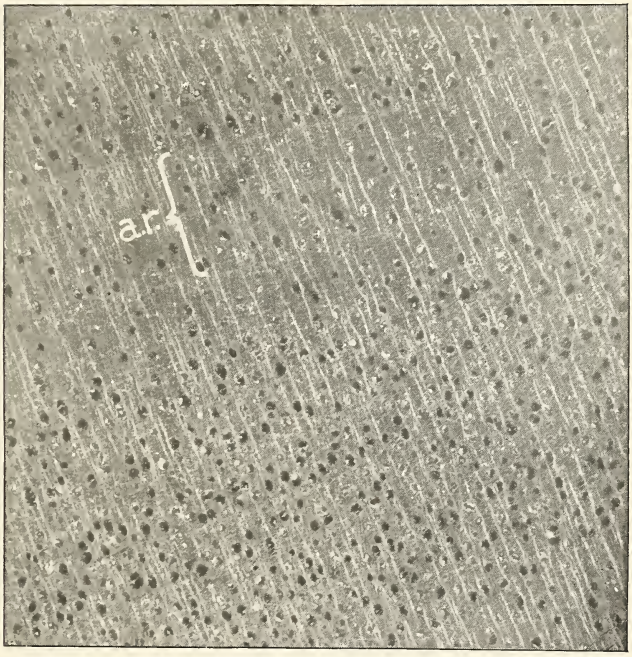
Black-walnut wood is heavy, hard, strong, and stiff. It is easy to split, has good shock-resisting ability, shrinks moderately in seasoning, is susceptible of a good polish, and takes paint, stain, and other finishes exceedingly well.

The results of certain Forest Service experiments on black walnut tested green are shown in Table 1 in comparison with oak. The strength values of the green wood are considered the best basis for comparison. Walnut compares still more favorably with oak when their dry weights are taken into consideration. For instance, black walnut, which has a dry weight of 85 per cent of the dry weight of oak, has shock-resisting ability 27 per cent greater and strength in bending 14 per cent greater than that of oak. As to strength in compression parallel to the grain, walnut rates 21 per cent higher, and in stiffness 14 per cent more. The shearing strength of walnut is only slightly less than that of oak. The hardness values of walnut and oak are in the same proportion to each other as their specific gravities—85 per cent. As to strength in compression perpendicular to grain, walnut has a lower value than oak. The shrinkage of black walnut in volume is less than that of oak, which is about 16 per cent. Shrinkage in the radial direction is about the same in both woods; but in the tangential direction the shrinkage of black walnut is less than that of oak. The ratio of radial to tangential shrinkage is much less in black walnut than in oak. In weight, and likewise in dimension, walnut changes slowly with changes in atmospheric conditions.

TABLE 1.—*Properties of black-walnut wood, actual and comparative, tested green.*

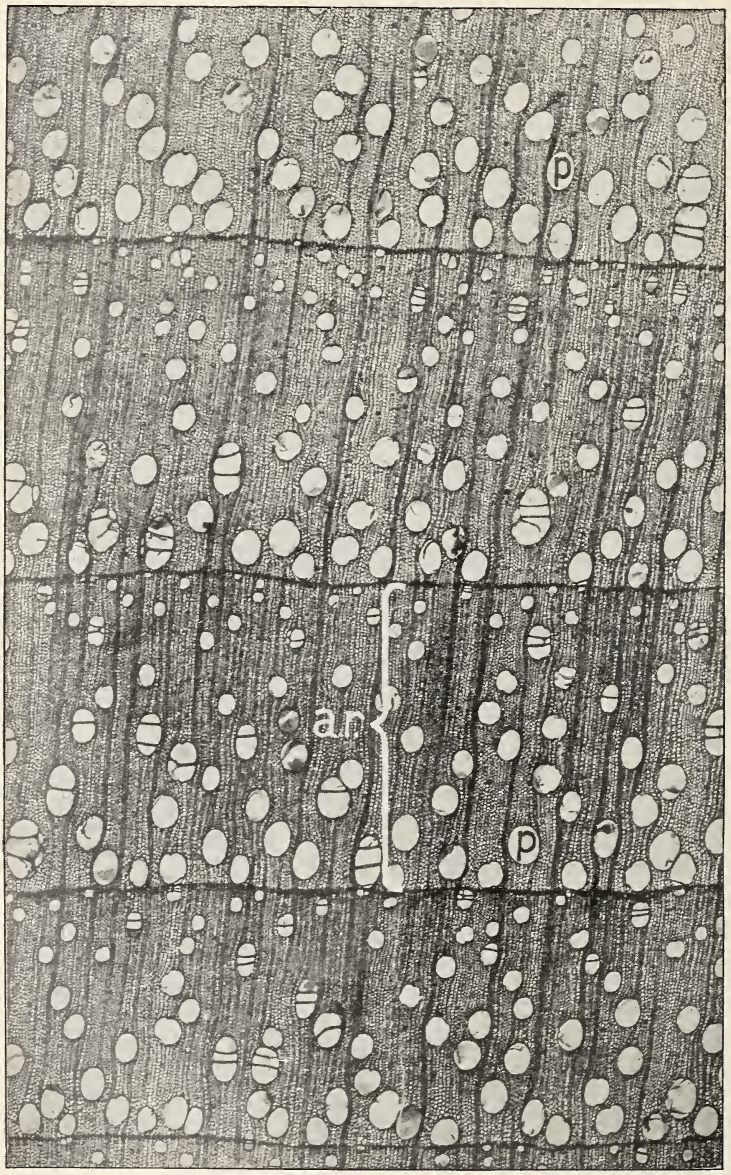
Common and botanical name.	Locality where grown.	Weight per cubic foot.			Specific gravity, oven-dry, based on volume when green.	Shrinkage from green to oven-dry condition.			Strength in bending.		Strength in compression parallel to grain.	
		Green.	Air-dry.	Kiln-dry.		In volume.	Radial.	Tangential.	Modulus of rupture.	Relative strength compared with oak (oak=100).	Maximum crushing strength.	Relative strength compared with oak (oak=100).
1	2	3	4	5	6	7	8	9	10	11	12	13
Walnut, black (*Juglans nigra*)..	Kentucky.....	*Pounds.* 58	*Pounds.* 39	*Pounds.* 37	0.51	*Per cent.* 11.3	*Per cent.* 5.2	*Per cent.* 7.1	*Lbs. per sq. in.* 9,500	114	*Lbs. per sq. in.* 4,300	121

Common and botanical name.	Locality where grown.	Strength in compression perpendicular to grain.		Stiffness.		Hardness.		Shock-resisting ability.		Shearing strength parallel to grain.	
		Fiber stress at elastic limit.	Relative strength compared with oak (oak=100).	Modulus of elasticity in bending.	Relative stiffness compared with oak (oak=100).	Load required to embed a 0.44-inch ball one-half its diameter.	Relative hardness compared with oak (oak=100).	Work to maximum load in bending.	Relative shock-resisting ability compared with oak (oak=100).	Shearing strength.	Relative shearing strength compared with oak (oak=100).
1	2	14	15	16	17	18	19	20	21	22	23
Walnut, black (*Juglans nigra*).....	Kentucky.....	*Lbs. per sq. in.* 600	72	*1,000 lbs. per sq. in.* 1,420	114	*Pounds.* 900	85	*Inch-lbs. per cu. in.* 14.6	127	*Lbs. per sq. in.* 1,220	98



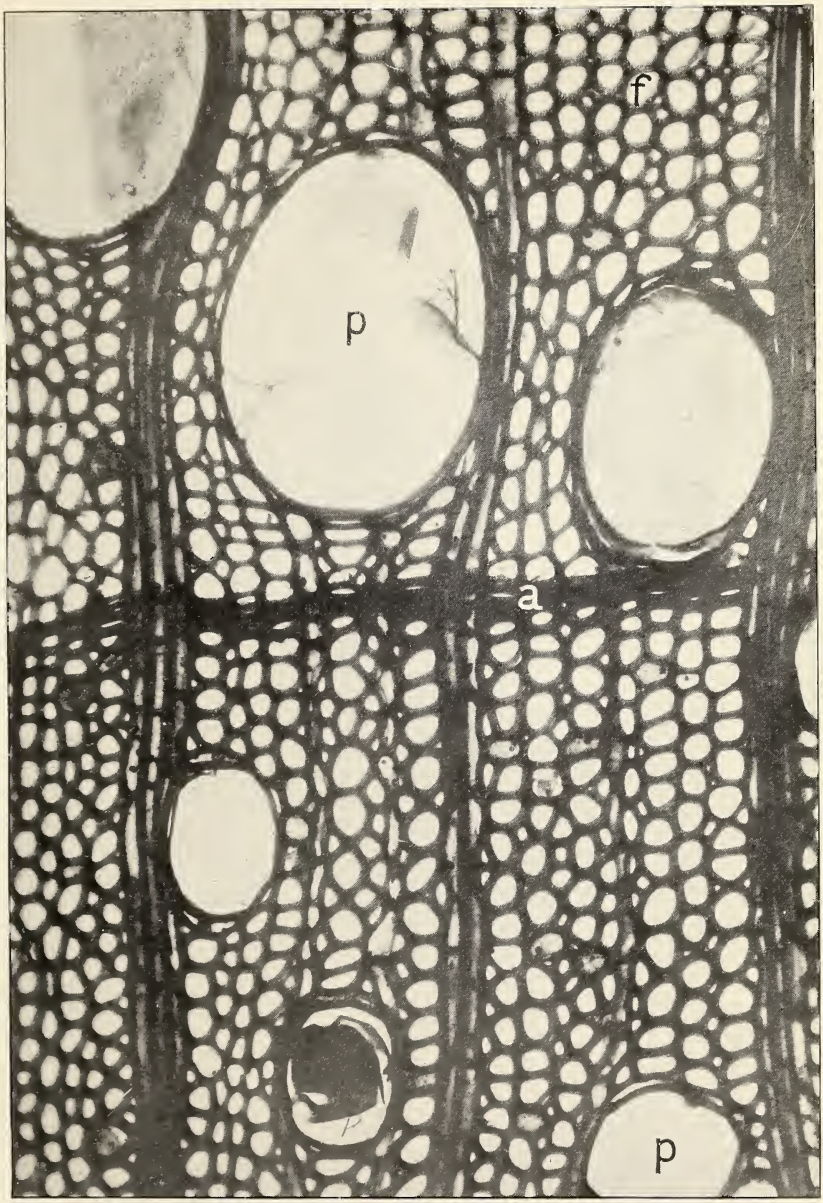
CROSS SECTION OF BLACK-WALNUT WOOD MAGNIFIED 7½ DIAMETERS.

a. r., annual ring.



CROSS SECTION OF BLACK-WALNUT WOOD MAGNIFIED 20 DIAMETERS.

a. r., annual ring; p., pores.



CROSS SECTION OF BLACK-WALNUT WOOD MAGNIFIED 250 DIAMETERS.

p., pores; f., wood fibers; a., end of annual ring.

Black walnut is straight-grained, easily worked with tools, is not liable to warp and check or to shrink and swell to any considerable extent after it has been seasoned, and glues well. These qualities add greatly to its value as a cabinet wood. Table 2 shows the properties of various cabinet woods in comparison with walnut as a basis. These are composite values (excepting those of weight and shrinkage), each being based on several different kinds of tests. The data show that walnut compares favorably with white and red oak in strength as a beam or post, in shock-resisting ability, and in stiffness. The hardness of walnut, however, is less than that of oak. In shock-resisting ability and stiffness birch is superior to walnut, although the two woods are about equivalent in strength. Birch is not so good in holding its shape after it is seasoned, and is also more liable than walnut to be cross-grained. Sweet birch is harder than walnut, and yellow birch is softer. Red gum ranks much lower than walnut in respect to these different properties. Oak and birch have greater dry weights than walnut, while red gum is lighter. All of the native cabinet woods listed have greater shrinkage values than walnut, with the exception of the radial shrinkage of oak and red gum. The volumetric shrinkage values of these woods are considerably greater than those of walnut. Walnut, therefore, compares very favorably with our other native cabinet woods in regard to these basic properties.

TABLE 2.—*Properties of various cabinet woods, compared with black walnut. Black walnut=100.*

	Strength as a beam or post.	Shock-resisting ability.	Stiffness.	Hardness.	Specific gravity, density, or weight.	Shrinkage (from green to oven-dry condition based on volume when green).		
						In volume.	Radial.	Tangential.
White oak (*Quercus alba*)	92	98	92	125	114	141	100	127
Red oak (*Quercus rubra*)	84	99	88	111	108	127	74	157
Sweet birch (*Betula lenta*)	98	115	111	113	114	134	119	107
Yellow birch (*Betula lutea*)	99	124	109	93	107	150	140	127
Red gum (*Liquidambar styraciflua*)	76	78	84	67	86	134	98	139
True mahogany (Central America) (*Swietenia mahagoni*)	95	68	87	90	87	70	67	68

NOTE.—The relative-strength figures given in the first four columns of this table are based on composite values, each of which is a combination of several different kinds of tests.

The true mahogany of Central America, listed in the table, shows a slightly lower value than walnut in strength as a beam or post. In stiffness and hardness it is much lower. Its shock-resisting ability is far below that of walnut. The amount of shrinkage in Central American mahogany is much less than in any of the native cabinet woods listed. The relation between volumetric, radial, and tangential shrinkage is about the same as for walnut.

STRUCTURE.

Black walnut is classed as a diffuse-porous wood, the pores being scattered throughout the annual-growth ring. These pores are comparatively large in size and easily visible to the naked eye, especially in the spring wood, and they gradually decrease in size toward the outer portion of each annual ring. Tyloses are present but do not completely fill the pores. The large pores of the spring wood sometimes give the appearance of a ring-porous arrangement. Plates I, II, and III show the structure of the wood in cross section at different magnifications. The pith rays are narrow and can not be seen without the aid of a hand lens. The structure of butternut wood closely resembles that of black walnut, but the wood of the former may be distinguished from the wood of the latter by its light chestnut-brown color.

INSECT AND FUNGUS ATTACK.

Black-walnut timber is largely free from insect and fungus attack in the tree, log, lumber, and finished product. Thrifty trees are generally sound. If the trees are very limby and are found on poor soils where growth is less vigorous, decay often gains access, through knots, to the interior of the tree trunk. A heart rot sometimes attacks the central portion of the trunk at the butt. This is called red butt rot and is most often found in the northeastern section of the area of distribution. It is especially prevalent in trees originating from sprouts, the fungus making entrance from the stump of the original tree as it rots away. Large white grubs also often gain access to the butt, and generally burrow out a small portion only. Injury from these agencies does not usually cause a loss of more than 1 to 3 feet of the merchantable length at the butt, although occasionally it may extend the entire length of the log. A more serious fungus attack than the red butt rot is a white top rot which is found mostly on the walnut of the southwestern area. This rot often extends over the greater part of the entire merchantable length of the tree, and often renders a log unsuitable for manufacture into either lumber or veneer, on account of the discoloration of the wood caused by the fungus attack.

Defective trees and logs are often attacked by small larvæ which leave what are called "pin holes." Such an attack often causes black streaks in the wood, and this damage unfits it for use on the face of veneered panels. In general, western timber suffers more than eastern timber from such attacks.

Walnut suffers little injury from fungi or insects either in the lumber or in the finished product. Green lumber or lumber partly dried is subject to fungus attack, but there is little liability of injury if ordinary care is taken.

SUPPLY.

RANGE.

The black-walnut tree grows naturally over a large area extending from southwestern New England to central Nebraska, Kansas, Oklahoma, and Texas. The limits of its distribution are shown in figure 1. Within the limits of its range, however, there are regions unfavorable to its growth where it is almost unknown. Black walnut grows best on soil that is rich, moist, and deep, but not wet. It is,

FIG. 1.—Botanical range of black walnut (*Juglans nigra*).

therefore, not generally found on the higher elevations throughout its range, nor on wet bottom lands, but in moist coves, on fertile hillsides, and on the well-drained soil of valleys and bottom lands. A limestone soil or sandy loam containing a large quantity of humus, overlying a deep subsoil of gravel, with a sufficient water supply, furnishes ideal conditions for growth. West of the Mississippi the walnut is confined generally to river valleys and moist situations.

The region throughout which black walnut is found in sufficient quantities for commercial exploitation is much more restricted (fig. 2). This region excludes the following areas embraced within its botanical range: Practically all of New York; the greater part of Pennsylvania, chiefly the mountainous and the northern portion; nearly all of New Jersey and Delaware; all but the central part of Maryland; southeastern Virginia, all but the western portion of North Carolina, and the regions of relatively high altitude in those

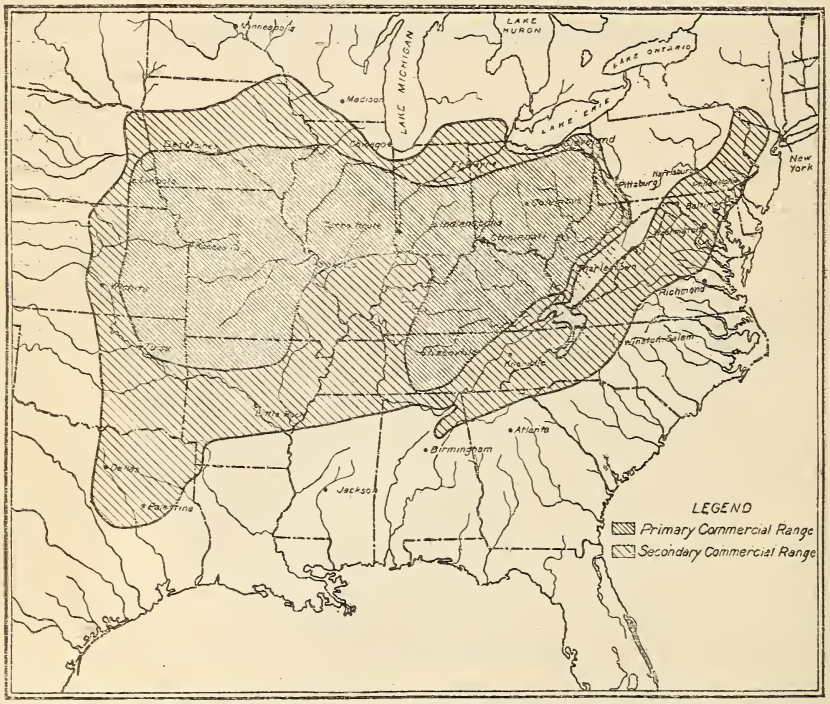


FIG. 2.—The area of primary commercial importance indicates in a general way where walnut is found in comparatively large quantities. The area of secondary commercial importance includes the region where it generally occurs in quantities large enough for commercial exploitation.

States (as also of West Virginia); practically all of the area included in the other Atlantic and Gulf States; southern Arkansas, and parts of other States on the border of its botanical range.

Throughout the commercial range indicated walnut is, of course, not everywhere found, as, for instance, on barren soils, the high ridges of Tennessee and North Carolina, and the low bottom lands. On the other hand, in the montainous sections of Virginia and West Virginia, where it is shown to be unimportant, many rich coves and fertile valleys contain profitable stands of excellent walnut timber.

The area of principal or primary commercial importance is also indicated in figure 2. This area excludes the mountainous high-altitude region of eastern United States, the region east of those mountains, Texas, Wisconsin, Michigan, and parts of States whose remaining area is within its principal commercial range.

SUPPLY OF TIMBER IN DIFFERENT REGIONS.

Table 3 gives the estimated amounts of standing black-walnut timber, by States and groups of States, for trees 12 inches and over in diameter at breast height. This estimate is based on available data from various sources, and is subject to revision as more definite data are obtained. The amount of timber available for commercial uses is, of course, considerably less than this, because many walnut logs less than 14 inches in diameter at the small end are not merchantable. Moreover, much of the timber included in the estimate is in small amounts too scattered to warrant its removal. A very large part of it is also inaccessible under present conditions; however, as conditions change, timber formerly inaccessible becomes accessible. Any statement, therefore, as to amounts available is mere conjecture.

TABLE 3.—*Estimated amounts of standing walnut, by States.*

[Trees 12 inches and over in diameter, breast high.]

State.	Amounts in millions of board feet, log scale.	Totals, by regions.	State.	Amounts in millions of board feet, log scale.	Totals, by regions.
Illinois	79	246	New York	2	36
Missouri	107		Pennsylvania	26	
Iowa	60		Maryland	5	
Kentucky	67	141	New Jersey	2	
Tennessee	60		Delaware	1	
North Carolina	14		South Carolina	7	28
Ohio	63	107	Georgia	8	
Indiana	44		Alabama	6	
Arkansas	46	101	Mississippi	4	
Oklahoma	18		Louisiana	3	
Texas	37		Michigan	15	28
Virginia	29	89	Wisconsin	10	
West Virginia	60		Minnesota	3	
Nebraska	18	45			
Kansas	27		Grand total		821

The locations from which walnut timber has been recently obtained are given in figure 3. This figure shows graphically the walnut timber that had been purchased by mills cutting gunstock blanks, and which was in the woods and at sidings at the time of the signing of the armistice.

ILLINOIS-MISSOURI-IOWA REGION.

[Estimated stand, 246 million feet.]

Estimates of standing walnut timber credit the Illinois-Missouri-Iowa region with approximately 30 per cent of the total. Large

amounts have been removed in recent years, but the supply has not been so greatly depleted here as it has, for instance, in Ohio and

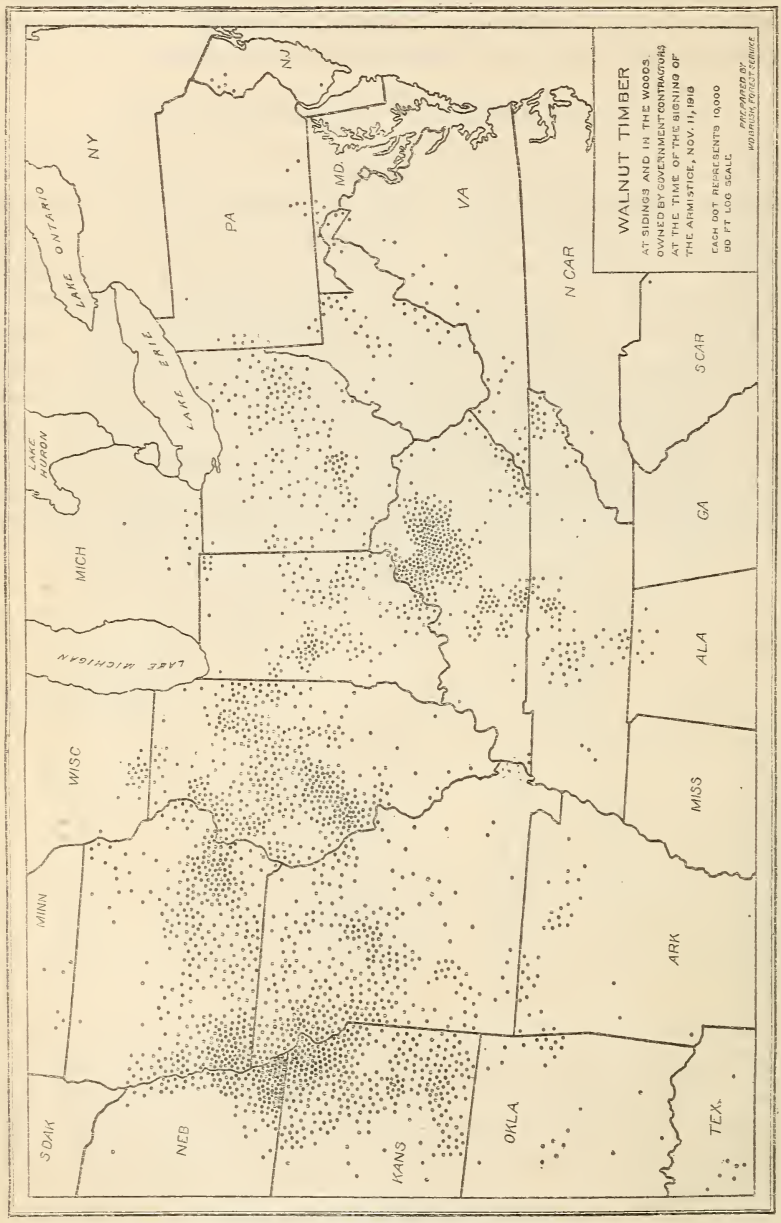


FIG. 3.

Indiana. It seems probable that the stand of walnut in this region was originally inferior to the Ohio and Indiana stand; but on account

of the exploitation being more recent and the timber being relatively inaccessible, the best supplies are now located in Illinois, Missouri, and Iowa. This region is, on the whole, fairly well adapted for the growth of walnut, which is quite generally distributed throughout the section, except on the poorer and drier upland soils and low, wet bottom lands. The best timber is to be found on land that has never been cleared for cultivation.

The principal walnut area in this region comprises southern Iowa and northern and central Missouri. In Iowa, walnut is found in commercial quantities principally along the streams. On the higher elevations in the northeastern part of the State merchantable trees are rarely seen. Southeastern Iowa was one of the most important sources of walnut timber during the war. There are still many valuable stands in the southern and southeastern parts of the State, chiefly on broad river bottoms where the soil is not too moist. Missouri is by far the banner State in respect to the total amount of standing walnut timber. It is said that walnut is found growing along the streams in every county. In northern Missouri, black walnut is confined principally to the alluvial soils adjacent to the streams, where the deep moist loams maintain some excellent stands. Central Missouri is also an important walnut region, especially in the western part, where there are comparatively heavy stands of walnut continuous with those of eastern Kansas. In the Ozark region of southern Missouri the walnut growth is confined to the lower elevations, principally to the deep moist soil of the stream courses. In such locations it attains large size, and in the aggregate there is a large amount of excellent walnut timber in the Ozark region, although much of the best has been removed. The low bottom lands of the southeastern portion of the State do not generally contain walnut in commercial amounts.

In northern Illinois, and particularly in the northeastern portion, there is comparatively little walnut. There is also very little on the low bottom lands of the southern portion. The principal supply is located in an east and west belt occupying the middle third of the State. Here it is confined largely to moist situations.

The walnut timber in the Illinois-Missouri-Iowa region does not, in general, grow so large as that of Ohio and Indiana. Nevertheless, as it has been culled less extensively than that farther east, the general run of the timber is probably as good as the average or better.

KENTUCKY-TENNESSEE-NORTH CAROLINA REGION.

[Estimated stand, 141 million feet.]

The presence of comparatively large supplies of walnut timber in Kentucky, Tennessee, and North Carolina is due in large part to the relative inaccessibility of the region. The best timber is now

probably in the mountainous areas of eastern Kentucky and Tennessee and western North Carolina, where it grows to large size in moist coves and in the rich soil of creek bottoms and valleys. Along the streams, however, the largest timber has been taken, and the small coves are now, as a rule, the best sources. On the slopes of the ridges, where the soil is deep, moist, and loamy, particularly on the north slopes, are supplies of walnut, but the trees seldom grow to large size there. At the higher altitudes and on the ridges, where the soil is poor and lacking in moisture, the trees are small and defective. Over a large part of the mountainous region the walnut has been removed in the process of lumbering for such species as yellow poplar, with which it is generally associated in this region. In former years, because of the large size to which the trees in thrifty stands in this section generally attain, it was the practice to take only the very large timber. As a consequence many trees of good size have been found in recent years. Throughout the large timbered areas of the mountains the walnut is so scattered that it is, as a rule, impracticable to log the walnut alone. Estimates made by the United States Forest Service of mountain timber in this area show an approximate stand of 28 board feet of walnut to the acre in virgin timber and 4 feet to the acre on cut-over lands. As a rule, therefore, the walnut timber of the mountain region will become available only as it is released by general timbering operations. There are many comparatively small agricultural areas scattered throughout this mountain section in which walnut occurs as a shade or field tree or mixed with other hardwood timber. In such localities, however, the most valuable trees have usually been culled out.

Outside of the western portion of North Carolina, walnut is not of frequent occurrence in this State. Immediately to the east of the more mountainous section there was formerly much walnut timber on good soils, but this has been very largely removed as the country became populated, and merchantable trees are now infrequent.

There are considerable amounts of walnut in Kentucky and Tennessee north and west of the mountainous regions. Throughout central Tennessee there is a great deal of walnut scattered over the agricultural lands. Many of the trees are, however, small and defective, for the most desirable ones have been cut out. It is estimated that only about 16 per cent of the stand in the entire State of Kentucky is located in the western half, and this is nearly all in the west central part. There is little in the western third of the State. In central Kentucky there is a very large area in which walnut grows in quantity, principally in fertile sections of the bluegrass region in the east central part of the State. Much walnut has been obtained from this section in past years on account of its

accessibility, and, although the supply has been greatly diminished, there are still stands of merchantable walnut to be had here. Probably the best available supplies in this part of the State are located in southeast central Kentucky, in localities far from the railroad, whence a haul of 15 to 20 miles or more is necessary. In eastern Kentucky, in the territory drained by the Big Sandy River, there is a good supply of walnut, but it is difficult to get it out because of lack of roads and on account of the roughness of the country. In the rugged southeastern part of the State, in fertile, moist valleys, there are supplies of good quality. On mining lands in this area, which have not been cleared, there is considerable walnut. The cost of logging in that kind of country is naturally very high. The lowlands of western Kentucky and Tennessee are not so well adapted to the growth of walnut, and only small amounts are found there.

OHIO-INDIANA REGION.

[Estimated stand, 107 million feet.]

The Ohio-Indiana region, which now stands third in importance, held first rank in lumber production for several years prior to 1914. It is remarkable that a region which has yielded so much walnut and which is so largely given over to agriculture should still contain such large amounts of this timber.

In Indiana, walnut is quite generally distributed over the entire State, but is most plentiful throughout the central portion. It is not important in the northwestern part of the State; and in the southern portion, which is somewhat rugged, it is confined to fertile valleys and slopes. Over a large part of the State, in which there are extensive areas of purely agricultural land, walnut trees, as well as other timber trees, have largely disappeared, except for a shade tree here and there, or a small patch of woodland, which the agriculturalist has spared. Along streams and in moist, fertile gullies throughout the State walnut is somewhat common. Such trees as are found, however, are more often small or otherwise not merchantable. That Indiana for a good many years continuously produced large supplies of walnut is accounted for by the fact that the species was distributed almost everywhere on good lands.

In Ohio, walnut is found generally except in the extreme northern part. The extreme western part of the State is fairly level and unbroken, and is almost entirely agricultural land similar to that in central Indiana. In consequence, the walnut and other timber has been very largely removed. The central, southern, and eastern portions, which are rougher, have the greatest amounts. Of these three sections, the central part, being the most settled, has the least. Over a large part of the extreme southern portion, the land is not

suitable for the growth of walnut, but in fertile sections and valleys there is much walnut available. The eastern portion of Ohio is in general very rolling, and this area has the largest amounts. There is much nonagricultural land here among the hills and valleys. Fertile, moist slopes and valleys contain some excellent stands of the best quality of forest-growth walnut. In northeastern Ohio the walnut is scattered, is generally below the average in size, is likely to be limby, and shows a large proportion of one-log trees.

ARKANSAS-OKLAHOMA-TEXAS REGION.

[Estimated stand, 101 million feet.]

Walnut is of commercial importance in the Arkansas-Oklahoma-Texas region principally in eastern Oklahoma, northwestern Arkansas, and northeastern Texas. It is generally confined to fertile, moist locations along the streams, but avoids the low, wet bottom lands. The best walnut has been removed from this region, except in the rough, inaccessible areas, and these are chiefly in Arkansas.

The greater part of the walnut in Arkansas lies in the Ozark region north of the Arkansas River. Throughout this region there are many valleys which have a rich, moist, deep, loamy soil. In such valleys and on moist hillsides there are good stands of walnut of large size. The forest-growth walnut of this region is said to yield a higher percentage of clear material than that from farther north in Iowa and Missouri, which is largely open growth. A considerable amount of walnut is said to have been taken out of the northwest corner of Arkansas in recent years.

In Oklahoma and Texas the walnut is generally very limby and defective. In Oklahoma the best walnut is found on the fertile alluvial soils of the bottom lands, along the stream courses of the northeastern and east central parts of the State. Practically all of the desirable black walnut in the State is found east of the ninety-seventh meridian, principally along the Arkansas, Verdegris, Canadian, and Red Rivers. The black walnut west of this line is small in size, short-boled, scrubby, and very defective.

In Texas the best walnut is in the extreme northeastern part, and particularly in the Red River valley, but even this is rather poor in quality. In general, the black walnut is found north of the thirty-first parallel and east of the ninety-seventh meridian. In eastern Texas the walnut is largely confined to the better-drained, but moist, bottom lands. Along the larger rivers these bottom lands are frequently 5 miles or more in width, and the soil is rich and deep. If the soil is not too wet, walnut makes a good growth here. However, the more valuable timber has been removed from these localities. Present supplies usually stand 10 miles or more from the railroad.

Over the greater part of eastern Texas the best walnut has been taken out during the past 15 or 20 years and shipped to Europe through the Gulf ports. The level country and good railroad facilities made possible the shipment of the greater part of the best timber. South of the Trinity River and west of the ninety-seventh meridian, black walnut is replaced by Mexican walnut (*Juglans rupestris*), which is often marketed as black walnut, but is inferior in quality.

VIRGINIA-WEST VIRGINIA REGION.

[Estimated stand, 89 million feet.]

Walnut is not found at the higher elevations in the mountainous regions of southeastern West Virginia and northwestern Virginia nor in the coastal-plains region of southeastern Virginia. There are, however, many fertile valleys in the mountainous section, excluded from the commercial range on the map, in which there are small commercial stands of walnut of good quality.

In West Virginia the main walnut area occupies, roughly, the northwestern half of the State, the bulk of the timber being in the northeastern portion of this area. The largest amounts are at present in the region lying between Fairmont and Charleston. The Elk River region, exclusive of the headwaters, contains much walnut. Some excellent walnut timber is found in the southwestern part of the State, but the greater portion of the timber is difficult of access. In the territory traversed by the Great Kanawha and New Rivers the walnut has been largely cut out, and only an occasional tree remains.

During the recent war this northwest section of the State, which had not been heretofore closely worked for walnut, largely because the timber was below the average in size, was drawn upon heavily for war needs, and much suitable material was obtained. This territory is not very extensively traversed by railroads, however, and much timber remains to be cut if the demand warrants it. In the southeastern half of the State there are many broad valleys, and those whose altitude is not too great contain merchantable stands of good quality. Many of these rich, fertile valleys originally contained large amounts of excellent forest-growth walnut, the greater part of which was removed 15 to 20 years ago, the timber being hauled long distances over mountain ranges and shipped for exportation. An occasional stand of virgin walnut timber is still found in this section of the State, but is likely to be too small in amount to warrant the necessary long haul to the railroad. In southern West Virginia, because of the high altitude and the poorness of the soil, there are not many walnut trees.

In Virginia, stands of merchantable size are generally confined to fertile valleys. The Shenandoah Valley, on account of its fertility and its limestone soils, originally contained large amounts of excellent walnut timber. This timber has been very largely removed, because it was accessible to the railroad, and only an occasional tree remains. The valley is now worked largely for veneer logs, because walnut is not found in sufficient quantity to warrant its being cut for saw timber. The best walnut region extends from Winchester to Staunton, and the best supply is now being obtained from the southern part of this area. South of Staunton the land is more rugged and walnut is scarce. In extreme western Virginia walnut is seldom found, because of the high altitudes and the barren soils. East of the Blue Ridge Mountains commercial stands are generally confined to stream valleys. Scattered trees are the rule in this area.

NEBRASKA-KANSAS REGION.

[Estimated stand, 45 million feet.]

In Kansas and Nebraska, walnut is limited to the eastern parts, and the principal commercial stands are in southeastern Nebraska and eastern Kansas. It is usually found along the streams and in alluvial river bottoms, where comparatively large amounts are available, the walnut making up a large percentage of the total timber stand. The walnut timber has been exploited in this region probably less than in any other in proportion to the existing supply, and this section is one of the best sources, if not the best source, of this wood at the present time.

NEW YORK-PENNSYLVANIA-MARYLAND-NEW JERSEY-DELAWARE REGION.

[Estimated stand, 36 million feet.]

In New York, Pennsylvania, Maryland, New Jersey, and Delaware, walnut is very much scattered and the supply is small in proportion to the total area, because walnut and other species have been taken out for many years. Some good forest-growth walnut is still found in southwestern Pennsylvania, in valleys and well-drained bottom lands of agricultural areas near the Ohio and West Virginia State lines. In central Maryland, also, some walnut of good quality is obtainable. For the most part, however, the walnut in these States is of the shade-tree kind. It is very limby, and the timber, consequently, is defective.

In New York State commercial stands of walnut are confined to a small area of scattered growth in the southeastern part.

In Pennsylvania commercial amounts are located only in the southeastern and southwestern parts of the State. These stands are found in rich agricultural valleys in which the soil is deep and moist, and

generally in such isolated amounts that they are not worth the cost of cutting and hauling. As a shade tree, walnut is found over the entire State, with the exception of the northern and most mountainous sections. These shade trees were taken in large amounts to satisfy the great needs of the war; in normal times, however, this source of supply is unimportant.

In western Maryland the altitude is too great, and walnut is not often seen. In central Maryland, in the region of Hagerstown and Frederick, limited quantities of merchantable walnut are still available. In eastern Maryland the soil is too poor and sandy for walnut to be of importance.

Walnut is often seen throughout the States of Delaware and New Jersey, and occasionally a large tree is found; but on the barren, sandy soils the trees are limby and very defective, and little saw timber can be produced from them. In extreme northern Delaware, walnut of good quality is sometimes found; the same is true of northwestern New Jersey, where the soil is more fertile.

SOUTH CAROLINA–GEORGIA–ALABAMA–MISSISSIPPI–LOUISIANA REGION.

[Estimated stand, 28 million feet.]

The total area in the coastal region from South Carolina to Louisiana in which walnut is commercially important is very small. In South Carolina it is found in quantity only in the northwestern corner of the State, at the higher elevations and on fertile soils. In Georgia there are commercial amounts in the valleys of the northern mountainous section and especially in the valley region of northwest Georgia, where it is found in quantity in the three tiers of counties next to the northern border. In northeast Georgia it is important only in the tier of counties farthest to the north. In Alabama the only walnut of importance is in the northeastern portion in the fertile valleys of the limestone region. This timber is difficult of access, however, and it will probably not be exploited soon. In Mississippi there is no walnut area of commercial importance. In Louisiana walnut is of commercial importance only in the Red River region, in the extreme northwestern part of the State.

MICHIGAN–WISCONSIN–MINNESOTA REGION.

[Estimated stand, 28 million feet.]

Walnut is now of little commercial importance in Michigan, Wisconsin, and Minnesota. It was formerly somewhat plentiful in southern Michigan, but now it occurs only as a single tree here and there. It grows to good size, however, and is occasionally cut for commercial purposes in the extreme southern part of the State. In southwestern

Wisconsin, likewise, the tree has a scattering growth, and in fertile woodlands it sometimes occurs in sufficient quantities for exploitation. The restricted region of commercial importance in southeastern Minnesota is continuous with the walnut area of Iowa.

QUALITY OF TIMBER FROM DIFFERENT REGIONS.

Walnut timber varies greatly in quality throughout the region of its growth. Climatic conditions have a large influence in producing this result, but the character of the soil seems to be the greatest factor. On poor, sandy, or shallow soils where there is little moisture the trees are usually undersized and defective; but on deep, rich, and moist agricultural land the timber grows to large size and is generally sound and of excellent quality.

On the agricultural lands of Ohio and Indiana walnut seems to reach its best development and is generally considered to be the best so far as the soundness and texture of the wood are concerned. The logs now obtained from this section naturally run small in size, but are, as a rule, sound and comparatively free from defects. A very great part of the walnut timber is now of the shade-tree kind, and generally produces only one log to a tree. Unless they have suffered some injury, trees of this kind are usually sound, often of large size, and suitable for manufacture into lumber or veneer if the sapwood is not too thick for the latter use.

If forest-growth timber of good size can be obtained it is generally of the best quality, and the logs are as a rule straight and symmetrical. Each tree usually yields several logs, and the top logs are often of good quality and comparatively free from defects. The heartwood is very dark and uniformly of good color. In these logs the sapwood is thin, and this makes them very valuable for veneer. Decay in trees of this kind generally occurs at the butt only and does not usually extend more than a few feet upward in the center of the log. Sawing off 2 or 3 feet from the butt log is generally sufficient to remove the worthless part.

The color of the heartwood of Ohio walnut is often ashen brown, and this is well liked for veneer. Heartwood from Indiana is apt to be dark or blackish brown. In the extreme northern and southern parts of these two States, which are regions not well adapted to walnut, the trees are likely to be limby and defective.

The walnut of central and eastern Illinois on good lands does not differ appreciably from that of central Ohio and Indiana. Where conditions are not so favorable for the tree, especially in the northern and southern parts of the State, it is of inferior quality.

Throughout central Kentucky and Tennessee the timber, taken as a whole, is good in quality but somewhat more defective than that

from Ohio and Indiana. It is claimed that this timber is sometimes shaky or badly worm-eaten, and these are very objectionable defects. There is a large proportion of field-growth walnut in this section. Trees of this kind of walnut often yield figured wood and are therefore in demand for veneer if they are not too defective. However, it is said that in much of this walnut the heartwood is not sufficiently dark in color to give an attractive appearance if it is used for veneer panels. Some of the peculiar brown tones are found in walnut from this section and occasionally those with a bluish cast which are well liked by the veneer manufacturer.

In the mountainous sections of the southern Appalachians, including adjacent parts of West Virginia, Virginia, Kentucky, Tennessee, North Carolina, and Georgia, the quality of the wood varies greatly, depending for the most part on whether it is grown on poor soils or in the fertile coves and valleys. The timber of the former localities is quite uniformly small and defective. In the latter sections, however, it grows to large size, and the timber is generally sound. In the rich valleys of this region on favorable sites there is excellent walnut timber, although isolated trees with spreading branches are now the rule. Even though but one log can be obtained from one of these trees, this log is generally a valuable one, because of its good form and the soundness of the wood.

In West Virginia, outside the mountain region, trees are, on the average, smaller in size than are the representative trees of Ohio and Indiana. West Virginia walnut trees generally branch nearer the ground, and the trunks are often badly shaped and defective. One-log trees are the general rule. As there is a good supply of walnut, however, much desirable timber is obtainable. The heartwood is dark in color.

In central Maryland the quality of walnut is fairly good, but the timber is generally in the form of field walnut, and is very limby. In eastern Maryland, Delaware, and New Jersey the trees have many limbs, and generally only one log is obtained from a tree, often a short log at that. Even if a log length free from limbs is obtained, it is often knotty, and the wood underneath is cross-grained and defective. Large trees are often found here, but their trunks are usually short and ill-shapen, and the wood inside is frequently cross-grained or decayed. Near the Pennsylvania State line the walnut is somewhat better in quality.

In Pennsylvania, where good walnut timber was found in the time of the early settlers, there are now generally only open-growth trees, the wood of which is defective. Good trees may still occasionally be found in the rich valleys, and there are some scattered stands of good quality in the agricultural lands near the central western border.

As a rule, however, the quality of the walnut available in the State is comparatively poor.

In general, the walnut of extreme eastern United States has many defects, including knots, decay, wormholes, and black streaks. Because of its open growth, however, the heartwood gives a figured effect when it is cut into veneer, and the different colors often produced by the eastern timber make it desirable for this use.

West of the Mississippi River the walnut timber does not on the average grow so large in size as the timber of the East, and the trees are apt to be more defective. Western timber often has a large proportion of hollow and rotten butts, and this defect may run the entire length of the butt log. Knots on the outside of the logs often indicate decay that extends to the interior. Logs cut from the upper portion of the tree are generally small and knotty. Notwithstanding the defectiveness of much western walnut, the general run of the timber is better than that of the eastern, especially in the more remote sections of the country. This is because the western timber has not been cut over so much as the eastern. Western walnut as a rule has more figure than eastern, and this makes it desirable for the manufacture of veneer. It is also said to be harder in general than eastern walnut.

The Missouri timber, except that from the southeastern part, is somewhat above the average in quality. That from low, wet locations is very defective.

The walnut of Iowa does not vary greatly in quality from that of Missouri. In the best locations for its growth in the State, along stream courses, it averages somewhat better than the Missouri walnut. The walnut of Kansas is similar in quality to that of Missouri; where the land has not been so greatly cut over the trees run larger and are less defective. The walnut of southeastern Nebraska is of very good size and quality, because the land has not been cut over to the extent to which it has in a large part of Missouri and Kansas.

The walnut of northwestern Arkansas is also said to be of a better quality than that from Missouri, the former being largely forest growth, and the latter, in a large measure, open growth. The hitherto greater inaccessibility of the Arkansas timber has contributed to produce this superiority. South of the Arkansas River the quality is more like that of the walnut of Oklahoma and Texas. Walnut from these two States is very inferior, especially that grown on the uplands. The main defects are crooked grain, windshake, sap pockets, wormholes, and large, loose knots. Logs from this region are, as a whole, not suitable for the manufacture of lumber. On account of these irregularities of growth, such logs produce a considerable amount of figure in veneer and are valued largely for this purpose. Different shades of color are often produced by the Texas walnut,

purplish tones being somewhat common. In the trees grown on the heavier soils the heartwood is quite dark in color. In open-growth trees there are often light and dark stripes of brown, which make a pleasing figure. Texas logs have been in demand for many years for making veneer if highly figured stock was desired.

Computations were made on approximately 12,000,000 board feet of logs purchased near the close of the war to show the average size of logs from different States. The average number of board feet to the log is shown in Table 4. These figures indicate that in the extreme northeastern, southeastern, and southwestern portions of the range the logs run below the average in size. With the exception of Ohio, Indiana, and Missouri, the States of the central and northwestern areas are above the average in footage. The small size of logs from these States is probably the result of the extensive exploitation of the timber there, particularly in Indiana. Walnut logs from Tennessee and Kansas also have low values, particularly as compared with values in the adjacent States, Kentucky and Nebraska, respectively. In Kansas the best timber has been largely cut out in recent years. In Tennessee and Alabama the trees run smaller in size than they do farther north. The very high average shown for Michigan is doubtless occasioned by the shipment of choice lots of timber.

TABLE 4.—*Average number of board feet in walnut logs from different States.*

State.	Board feet per log.	State.	Board feet per log.	State.	Board feet per log.
Michigan	106.63	Arkansas	76.02	Pennsylvania	63.51
Illinois	79.61	North Carolina	75.12	Virginia	60.71
Iowa	79.50	Kansas	75.06	Maryland	55.10
Nebraska	79.43	Texas	73.10	Alabama	51.88
Kentucky	78.67	Indiana	70.37		
West Virginia	76.95	Tennessee	69.37	Average for all logs	76.38
Ohio	76.20	Oklahoma	66.59		
Missouri	76.17				

DEMAND.

It is somewhat difficult to determine the total amount of walnut timber used annually, because of the fluctuation from year to year. Conditions prevailing during the war added greatly to the normal demand. The total demand for walnut is made up almost entirely of logs for export, logs for conversion into lumber and veneer, and timber for use as railway ties, posts, and fuel. On account of its high value, little walnut is used in rough building construction. Prior to the war the exportation of logs amounted to 7 to 12 million board feet, equivalent to between 8 and 15 million board feet of lumber; logs used for veneer amounted to 2½ to 4

million board feet, equivalent to 3 to 5 million board feet of lumber; and the total lumber cut was probably between 40 and 50 million board feet. This makes a total annual use of 51 to 70 million board feet, exclusive of the wood used for ties and fuel. The years 1911 and 1912 may be taken as representative or average years. The statistics for these years show an annual demand as follows:

Logs exported from the United States (1912), 9.82 million board feet; equivalent in lumber to about 12 million board feet.

Logs manufactured into veneer in the United States (1911), 4.12 million board feet; equivalent in lumber to about 5 million board feet.

Lumber production in the United States, estimated at 50 million board feet.

Total, 67 million board feet.

Reports of wood-using factories in the United States during the years from 1909 to 1913 show a total annual use of about 24 million board feet of black-walnut lumber and veneer for the manufacture of various products. As about 55 million board feet of lumber and veneer were manufactured annually in the United States in 1911 and 1912, the difference of 31 million board feet represents exportations, which were almost altogether in the form of lumber. The amount of walnut used for ties, posts, and fuel is difficult of estimate, but is small, compared with the total for all purposes.

During the war the demand amounted to about 90 million board feet annually. In 1918 the total lumber production was about 100 million board feet, which was cut for war purposes. There was no exportation of logs, and practically no veneer was produced that year.

The home demand for walnut at present is comparatively great on account of the marked increase in its use for cabinetwork. The total future demand depends very largely on the extent to which exportations approach or exceed the amounts sent abroad before the war.

UTILIZATION BY INDUSTRIES.

PRIMARY INDUSTRIES.

LUMBER.

PRODUCTION BY STATES.

Table 5 shows by States the reported amounts of walnut lumber produced in the different years for which statistics are available. The computed annual production of walnut lumber is also given for the years 1915 to 1918. This table shows that the annual production of black-walnut lumber in the United States for the past 15 and probably 20 years did not greatly exceed 50 million board feet up

to the year 1915. During the years 1915 and 1916 there was an increase of about 50 per cent over previous years. In 1917 there was a falling off in production. In 1918 there was an increase to 100 million board feet as a result of war demands. Missouri shows a marked increase in production, and Iowa a large output since 1914, because the large mills in these States obtained new supplies from a great part of the walnut region west of the Mississippi. The States of Kentucky and Tennessee have kept up a fairly steady cut of walnut lumber. Ohio, Indiana, and Illinois also have steadily furnished very large amounts from the beginning of the walnut-lumber industry.

TABLE 5.—*Reported production of walnut lumber, by States, in 1899 and from 1904 to 1918, inclusive; average value per 1,000 board feet of the product, f. o. b. mills; and total number of mills reporting.*

State.	1899	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Total number of mills reporting	31,833	[1] 18,277	11,666	22,398	28,850	31,231	[2] 48,112	[1] 31,934	[1] 28,107	[1] 29,648	21,668	[1] 27,506	[1] 16,815	[1] 17,269	[1] 16,420	[1] 14,753
Total number of mills cutting walnut	(3)	(3)	(3)	(3)	[4] 1,803	[4] 2,563	3,518	2,882	2,502	2,738	895	749	1,293	1,204	1,001	855
Average value per 1,000 board feet f. o. b. mills	$36.49	$45.64	(3)	$42.25	$43.31	$42.53	$42.79	$34.91	$31.70	(3)	(3)	(3)	$48.47	$42.38	$72.99	$77.60
Computed total cut													90,000	90,000	62,000	100,000
Total reported cut	38,681	31,455	29,851	47,174	41,490	43,681	46,108	36,449	38,293	43,083	40,565	25,573	65,144	61,167	53,676	87,305
Missouri	6,285	3,328	3,861	6,939	6,998	5,760	4,314	3,417	2,016	4,635	7,047	4,561	17,954	12,140	13,373	29,277
Indiana	10,637	8,359	8,957	12,924	9,975	8,358	7,669	5,237	9,755	6,425	10,194	4,626	11,267	10,691	7,872	11,941
Ohio	6,857	5,354	4,477	5,479	6,003	7,837	8,580	6,915	7,806	8,565	7,164	3,153	6,917	6,026	6,656	10,071
Tennessee	4,315	889	2,306	4,144	4,996	2,987	4,068	3,432	2,932	3,736	3,926	2,852	9,123	8,658	4,828	7,581
Kansas	(5)	(5)	(5)	(5)	(5)	(5)	1,114	7	(5)	(5)	81			27	4,010	7,507
Illinois	958	3,321	4,472	5,097	4,335	4,866	5,051	4,897	4,291	5,197	3,890	1,497	7,077	3,169	2,269	6,130
Iowa	4,313	86	104	107	108	298	858	821	594	655	290	4,974	4,439	6,497	3,719	5,416
Kentucky	2,113	5,094	3,704	5,546	4,893	4,633	4,907	4,684	4,022	5,855	3,450	1,754	4,007	8,138	8,112	5,263
Virginia	296	77	51	322	660	1,423	2,308	1,761	1,415	1,123	571	263	719	1,334	450	1,696
West Virginia	150	128	377	1,094	1,626	1,430	1,968	1,849	1,666	1,597	916	702	1,477	2,253	887	800
Arkansas	175	66	136	4,905	58	507	544	273	342	266	2,064	140	511	205	532	335
North Carolina	100	22	88	1	114	223	267	501	798	754	305	151	249	567	230	233
Louisiana	60									2		12		1		222
Nebraska	(5)	(5)	(5)	(5)	(5)	(5)			(5)	(5)	25					200
Pennsylvania	376		919	342	269	1,249	1,762	938	1,223	2,268	234	351	504	423	255	160
Michigan	451	240	154		25	254	184	265	184	177	31	92	43	175	42	110
Oklahoma	228	1,918		15	807	778	302	249	197	343	84	38	187	189	71	85
New Jersey	69			6	6	44	78	56	69	79	2	51	27	40	14	57
Maryland	23	32	20	38	10	198	362	265	246	284	33	45	89	101	67	46
Wisconsin	140	15		215	413	1,828	285	85	76	68	37	7	31	45	70	34
New York	141	2,010							3	8	12	7	20	34	35	25
Alabama	193	6			12	141	721	332	99	273	27	82	220	51	58	18
Georgia	100		10		5	8	48	99	31	82	5		133	100	35	17
Mississippi			144		10	16	33	46	75	66			15	64	1	17
Massachusetts	45	145			15	375	228	64	231	228	70	50	21	69	30	16
Florida										3						15
Vermont					15	21	5	5	28	8		10	14	60	1	8
Connecticut	62	285			25	201	186	91	87	73	4	115	27	19	11	7
Texas	63	30			16	4	79	92	30	2	53		49	39	5	6
Rhode Island	10					102	138	11		20	40	32		20	17	5
Delaware	21					21	6	11	5			7	3			4
South Carolina			4				11	9	32	207	1	1	10	19	20	1
Minnesota	5					6	28	15	9	25	9		1	8	2	1
New Hampshire						2	4	22	6	2			10	2		1

Maine	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....
California	60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
All other States	435	50	67	.....	96	111	.....	.....	25	57	.....	.....	.....	.....	.....	.....

[1] Mills cutting 50,000 feet and less excluded.
[2] Includes 4,543 mills cutting less than 50,000 feet; and all cooperage, veneer, millwork, box, furniture, and other factories cutting any lumber at all in 1909.
[3] Data not obtained.
[4] Mills in New York not included.
[5] Included in "All other States."

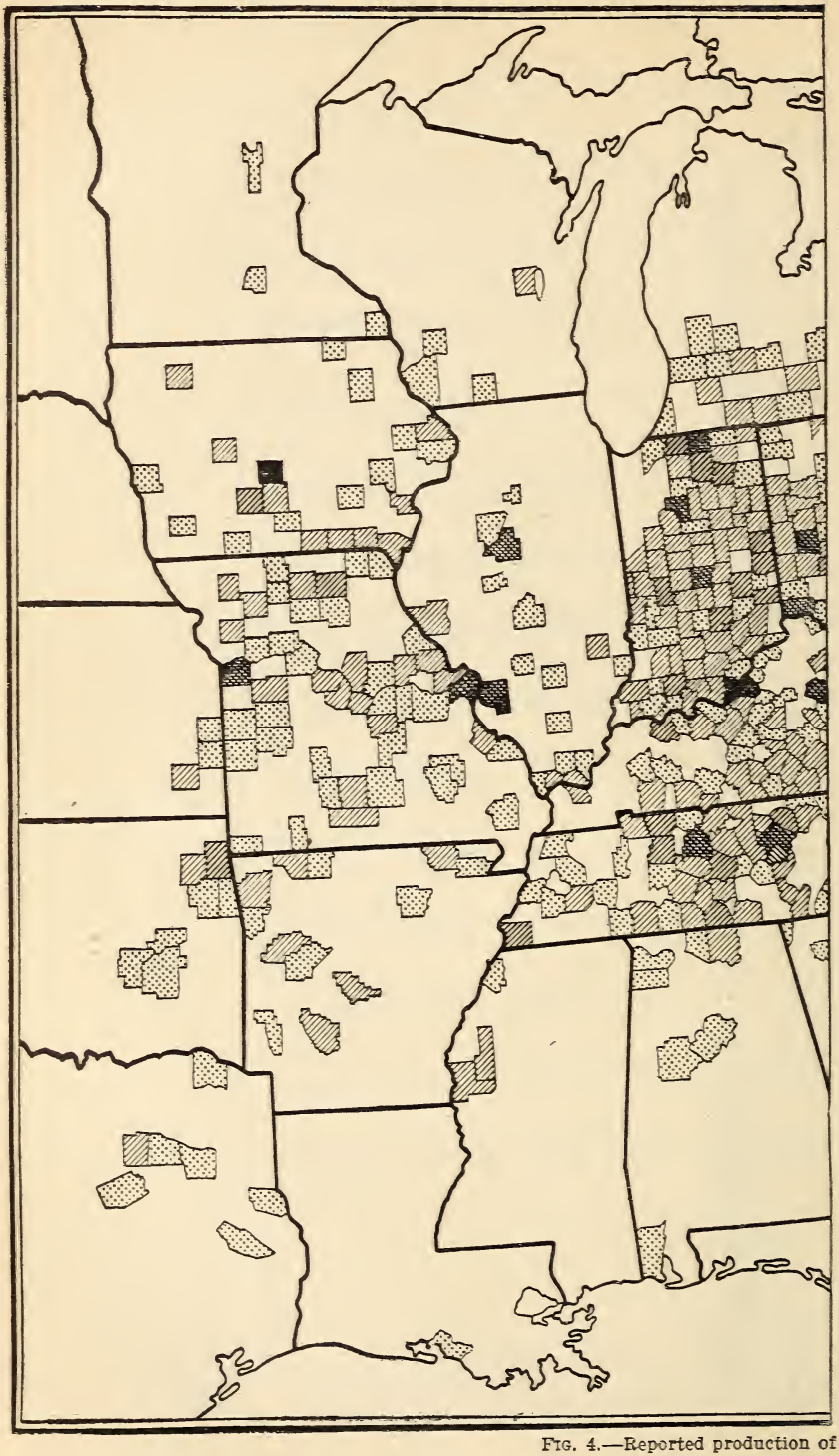
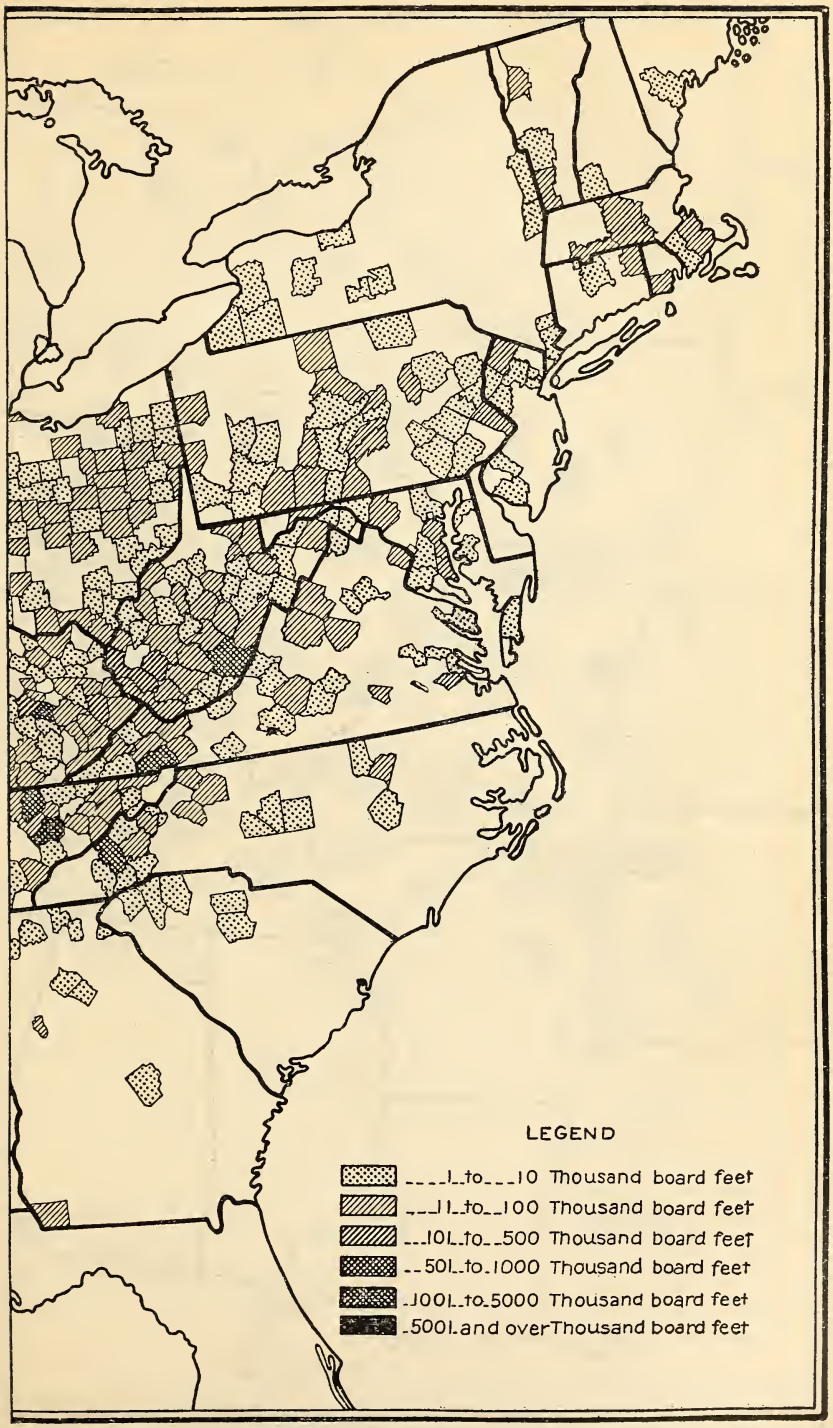


FIG. 4.—Reported production of



walnut lumber in 1916, by counties.

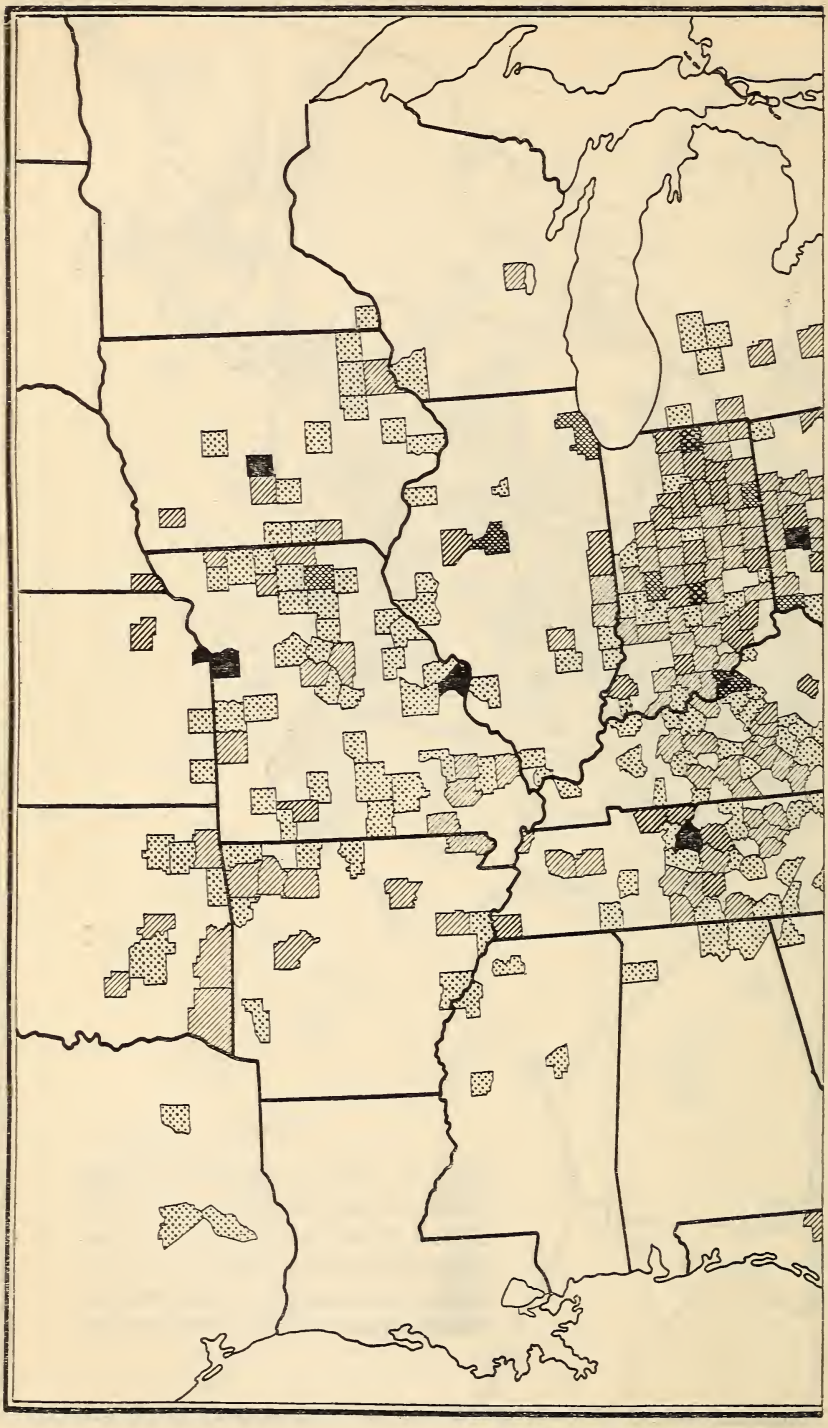
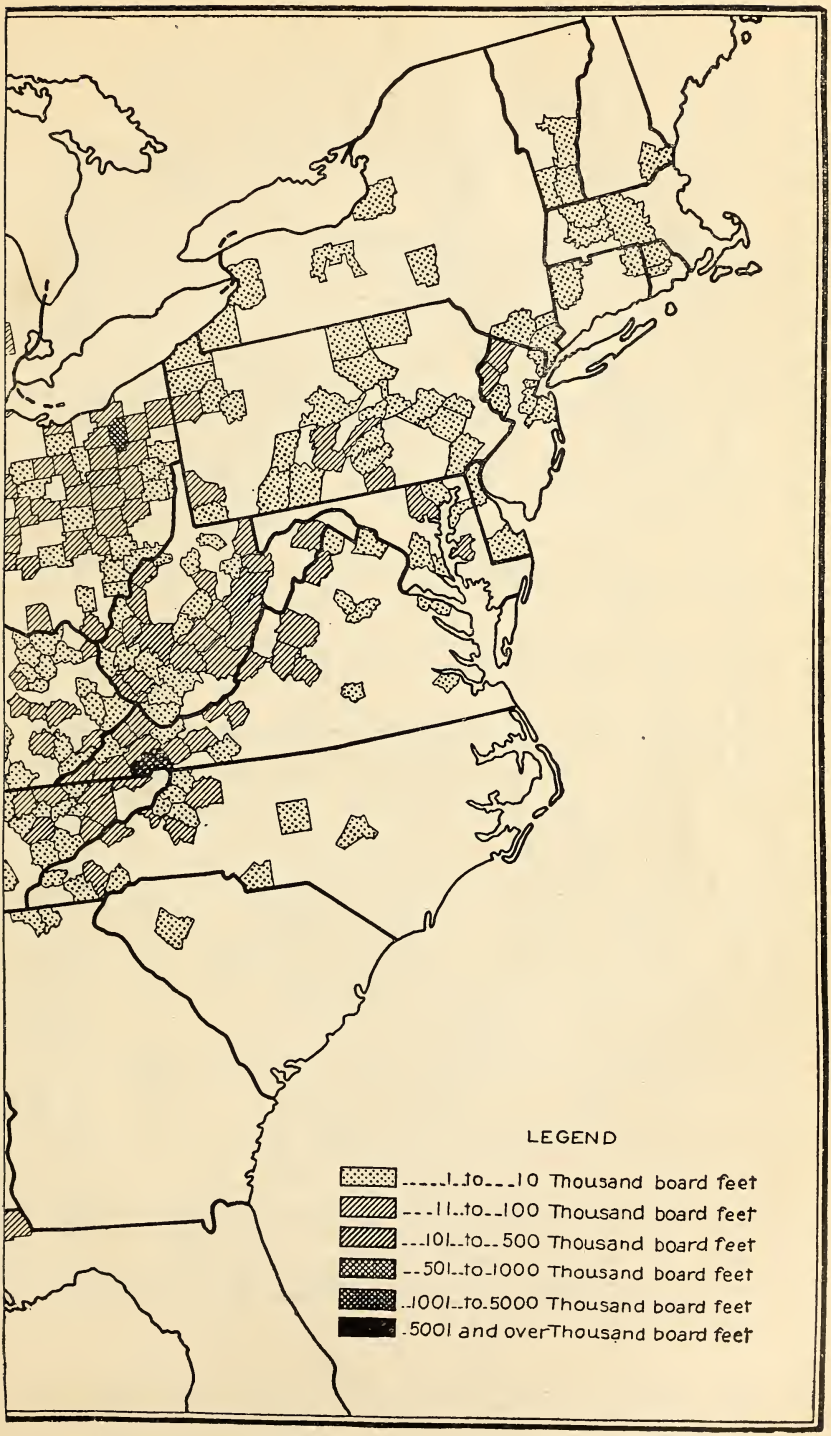


FIG. 5.—Reported production of



walnut lumber in 1918, by counties.

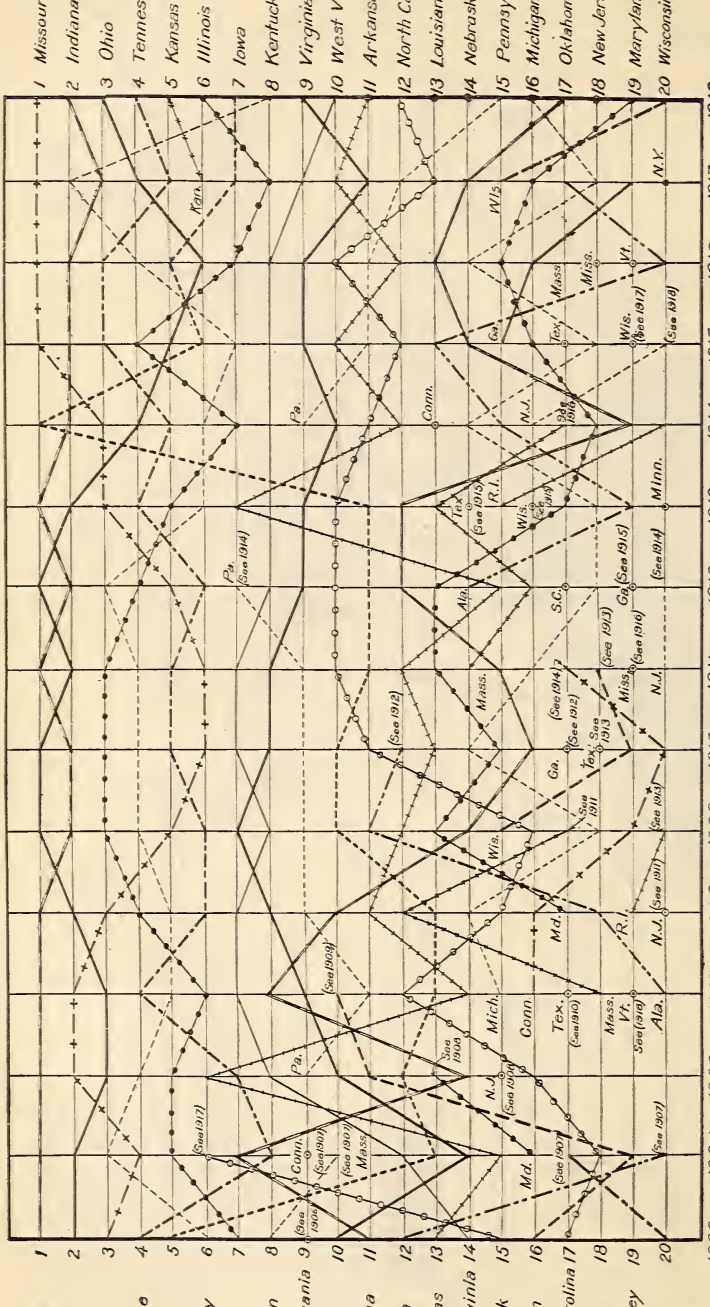


FIG. 6.—Rank of principal walnut lumber producing States in lumber output by years.

In West Virginia and Virginia the mills generally cut little walnut lumber, although these States furnish considerable saw timber. The logs are shipped very largely to mills in other States. The same is true of North Carolina and Arkansas. Pennsylvania, Michigan, and Maryland, which formerly furnished large amounts of walnut lumber, produced only small quantities during those years in which the output was recorded.

Figures 4 and 5 show graphically the reported production by counties for 1916 and 1918. These maps show a movement to the west of the Mississippi of a great part of the walnut lumber manufacturing industry.

Figure 6 shows the order in which the principal walnut-manufacturing States stood in different years in point of lumber production. It is quite remarkable that Indiana, Ohio, and Illinois, after a continuous and heavy drain upon this region for so many years, rank so high in 1918. Missouri, Tennessee, and Kentucky since 1899 have also maintained a notably steady output.

TABLE 6.—*Number of mills in the different States reporting manufacture of walnut lumber in different years, arranged in the order of lumber cut for 1918.*

State.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Total	1,803	2,563	3,518	2,882	2,502	2,738	895	749	1,293	1,204	1,001	855
Missouri	170	210	384	346	284	322	114	68	86	73	61	54
Indiana	385	478	544	421	346	413	191	176	223	203	189	149
Ohio	299	326	387	320	306	346	107	102	149	160	126	110
Tennessee	260	279	387	292	249	286	94	115	205	144	115	108
Kansas	*a*	3	6	3	*a*	5	3	.....	.....	3	*a*	4
Illinois	92	112	145	106	82	87	31	21	33	20	23	20
Iowa	*a*	50	114	82	82	72	27	8	45	32	31	22
Kentucky	315	348	419	367	315	320	110	77	149	153	122	96
Virginia	*a*	127	210	204	167	166	40	21	64	54	52	51
West Virginia	*a*	149	216	182	165	175	50	41	107	96	77	63
Arkansas	*a*	38	56	46	28	31	10	13	23	18	27	21
North Carolina	*a*	39	58	58	75	65	27	13	26	42	43	28
Louisiana	.....	.....	.....	.....	.....	*a*	.....	*a*	.....	*a*	.....	*a*
Nebraska	.....	.....	.....	.....	.....	*a*	*a*	.....	.....	.....	.....	*a*
Pennsylvania	*a*	177	258	179	181	204	30	39	72	71	50	43
Michigan	*a*	32	46	49	40	36	9	10	9	15	9	12
Oklahoma	*a*	34	42	43	36	40	10	5	11	12	9	12
New Jersey	*a*	13	18	20	18	12	*a*	4	11	11	4	8
Maryland	*a*	34	51	45	30	38	8	7	18	17	17	8
Wisconsin	*a*	24	26	12	12	14	6	*a*	11	7	5	*a*
New York	.....	.....	.....	.....	*a*	6	5	5	6	14	8	11
Alabama	*a*	20	51	38	21	23	3	10	14	8	10	3
Georgia	*a*	10	12	11	7	16	*a*	.....	5	11	4	3
Mississippi	*a*	8	4	8	3	5	.....	.....	*a*	3	*a*	4
Massachusetts	*a*	16	26	11	18	22	5	*a*	5	7	3	5
Florida	.....	.....	.....	.....	.....	*a*	.....	.....	.....	.....	.....	*a*
Vermont	*a*	5	*a*	*a*	3	4	.....	*a*	4	4	*a*	3
Connecticut	*a*	12	18	12	10	8	*a*	3	3	4	4	*a*
Texas	*a*	4	7	5	3	*a*	4	.....	4	8	*a*	3
Rhode Island	.....	7	8	*a*	.....	*a*	*a*	3	.....	3	5	*a*
Delaware	.....	*a*	*a*	*a*	*a*	.....	.....	*a*	*a*	.....	.....	*a*
South Carolina	.....	.....	10	6	9	10	*a*	*a*	5	5	*a*	*a*
Minnesota	.....	4	8	5	4	5	*a*	.....	*a*	3	*a*	*a*
New Hampshire	.....	*a*	3	5	4	*a*	.....	.....	*a*	*a*	.....	*a*
Maine	.....	.....	.....	.....	.....	.....	.....	.....	.....	*a*	.....	.....
All other States[1]	282	4	4	6	4	7	11	8	5	3	7	14

[1] Including those marked "*a*."

Table 6 gives for different years the number of mills in each State reporting the manufacture of walnut lumber. These are arranged

in order of importance for 1918. This table shows a marked and almost universal reduction in the number of mills sawing walnut in the different States, particularly since the year 1912. This reduction in the number of mills cutting walnut was, of course, to be expected for 1918, for during that year the manufacture of walnut logs was permitted only for war products. However, Missouri shows a reduction from 322 mills in 1912 to 61 in 1917, and Indiana a reduction from 413 mills in 1912 to 189 in 1917. Practically every State that had a number of mills sawing walnut several years ago has shown a great reduction. This is largely because walnut manufacture has become in recent years a highly specialized industry, and walnut logs are now generally worked up at a mill specially adapted for handling this kind of timber.

MANUFACTURE.

The manufacture of walnut lumber is one of the most exacting processes in sawmilling. The percentage of failures among walnut operators is notoriously high. The problem, naturally, is for the operator to get the most walnut lumber of the greatest value out of the saw logs, or so to regulate his sawing that as much of the log as possible will be utilized for products for which there is a demand and at a price that will yield the necessary profit. Walnut sawmill operators, therefore, do not strive for maximum lumber output. Care must be used in sawing each log, for improper manufacture produces a greater proportion of less valuable stock, and the operation might easily result in a loss rather than a profit.

Large walnut sawmills are equipped with modern band saws, which make a narrower kerf than the circular saws of small mills. This gives to the large mill the advantages of faster production and less waste in sawdust.

As walnut saw logs are nearly always defective, the sawyer must be able to judge, so far as possible from the outside appearance, the position and character of interior defects. Walnut logs are apt to be knotty toward the center, and the sawyer aims to get as much wide, fairly clear lumber as possible without running into the knots near the center. The position of the log on the carriage, the number and thickness of the boards sawed from the log, and the turning of the log at the proper time to saw from another side have much to do with getting a profit from the walnut-lumber business.

The cost of manufacture at large mills can not be easily determined, because the veneer operations are so closely tied up with lumber manufacture. At small mills the cost of sawing is generally placed at $7.50 to $10 a thousand feet.

It is a general practice among walnut-lumber manufacturers to subject their sawed stock to a steaming process as it comes from

the saw. The older method was that of piling the lumber in a pit made of boards, at the bottom of which was the open end of the exhaust-steam pipe from the engine. The lumber was then covered over with sawdust and kept in the wet steam for several days. (Pl. IV, fig. 1.) The common method now is to build one or usually several large, fairly tight compartments with large doors and, after the lumber is piled in these compartments, to close them as tight as possible and turn in the steam. This method has the double effect of giving the wood, including the sapwood, a uniformly brown color, and of expediting the process of seasoning. There is usually not sufficient exhaust steam for this purpose, and live steam also must be used. Operators ordinarily steam their stock from four to five days at a temperature of 140° to 160°. If live steam is used it is difficult to regulate the temperature with the usual equipment; for when little exhaust steam is available more live steam must be used, and a higher temperature results. To regulate the moisture and temperature of the steam there is an equipment used in which the live steam is run over tanks of water; as moisture is taken up, the temperature is reduced.

Forest Service tests on walnut steamed for 10 days at a temperature of 190° and at atmospheric pressure have shown a decided loss in shock-resisting ability, or "toughness," for the steamed material. It is likely, however, that no appreciable loss in strength properties results from steaming at the usual lower temperatures. Cabinetmakers report that they find little or no difference between the properties of steamed and unsteamed walnut as it is now placed on the market.

Steaming gives a more or less uniform color to both heartwood and sapwood and makes the sapwood as valuable on the market as heartwood; for, according to the grading rules, any amount of sapwood is admitted in steamed walnut. Steaming also shortens the seasoning period. Manufacturers claim that steamed walnut, properly piled and air-seasoned, in 30 days will be as dry as unsteamed green walnut that has been in the pile for 90 days. Steamed walnut lumber 1 inch thick is considered to be "shipping dry" after being air-dried 30 days; and 1½-inch steamed walnut is so regarded after being air-dried 45 days, or one week for each quarter inch in thickness. This procedure effects a great saving in the time required for seasoning. It is also claimed that the steamed lumber is not so subject to fungus attack and discoloration when it is piled for air-drying.

The amounts of different grades of lumber produced from walnut logs are very difficult to determine, because no two manufacturers use the same general class of logs for lumber, nor do they manufac-

ture the same kind of stock from them. The best that can be done, therefore, is to show averages derived from reports of several large representative manufacturers. These reports relate to grades of lumber produced and cover a considerable amount of material. The data are available for the years 1912 and 1919 and are as follows:

1912: First and seconds, 30 per cent; No. 1 common, 45 per cent; No. 2 common, 20 per cent; No. 3 common, 5 per cent.

1919: Firsts and seconds, 15 per cent; selects, 7 per cent; No. 1 common, 45 per cent; No. 2 common, 23 per cent; No. 3 common, 10 per cent.

From the figures covering the year 1912 the overrun of the log scale could not be determined. It is probable, however, that this overrun was greater than the average generally obtained from hardwood timber, because walnut logs usually run smaller. The high overrun during the war, amounting at many mills to about 40 per cent, was the result of sawing the thick gunstock flitches, which usually contained many defects. The small loss in saw kerf also helped to increase this overrun. For the year 1919 it is claimed that the overrun resulting from the sawing into lumber amounted to only about 10 per cent. This overrun seems remarkably low, but it is accounted for by the very poor quality of the logs remaining in the hands of the manufacturers that year, for a very large part of this timber was purchased to fill Government contracts and was intended mainly for rifle-stock blanks. Logs of that kind have many interior defects; and in most cases defects visible on the outside of the log were not scaled out, because the mill people were so desirous of obtaining the logs. Manufacturers claim that the 10 per cent overrun was entirely absorbed by the 10 per cent No. 3 common, or cull grade, which became unmerchantable, because of the very large amount of this low-grade stock on hand from the manufacture of war materials. Some walnut mills even claim an actual loss when the yield of merchantable lumber was compared with the amount of the log scale.

Under the present normal conditions, logs are scaled more closely for defects than during the war period; and, therefore, the overrun and also the proportion of firsts and seconds is greater. Furthermore, a better average grade of logs is being purchased. It is also probable that there will be a greater demand for cull or low-grade material.

The high percentage of the No. 1 common grade, as compared with that of other woods, is due, in the main, to the remanufacture of the No. 2 common grade. By resawing the widest and least defective lumber of this grade, narrower and shorter pieces are cut which will be classed as No. 1 common grade. In this way the amount of defective material is reduced.

GRADES AND PRICES.

The manufacture of walnut has become such a specialized industry that each log is generally purchased on its own merits without regard to grade. One classification used for walnut logs is grade No. 1 and grade No. 2. Grade No. 1 may have one or possibly two knots or other slight defects. Grade No. 2 includes all defective logs below grade No. 1 that are merchantable. Another classification used is Nos. 1, 2, and 3. No. 1 logs are practically clear, and generally 16 inches and over in diameter at the small end; No. 2 are of medium quality; and No. 3 of poor quality. This classification, of course, leaves much to the judgment of the log buyer. Manufacturers generally do not have any published grades. They usually purchase logs 14 inches and over in diameter at the small end, and the small sizes must be quite free from defects, particularly crook and large knots.

During the war the quality of logs was much lower than in normal times, on account of the pressing need for the timber. Small and defective logs were taken, which would not have been considered in peace times. Almost any log that would yield a clear gunstock blank was considered merchantable. The poorer class of such logs could be manufactured into lumber only at a loss.

Walnut lumber is classified by the National Hardwood Lumber Association rules according to five grades—namely, firsts and seconds, selects, No. 1 common, No. 2 common, and No. 3 common. In firsts and seconds the pieces must be at least 6 inches wide and 8 feet long. Each piece may have from one to three standard defects and a specified amount of sapwood, both depending on the size of the piece. In selects, pieces must be at least 4 inches wide and 6 feet long. In general, pieces of this grade are about equal in quality to the firsts and seconds grade on one face and to the No. 1 common grade on the other face. Specifications are given according to the size of each piece. No. 1 common must be at least 3 inches wide and 4 feet long. Each piece must be capable of yielding clear cuttings free from sapwood on one face and not over one-half sapwood on the reverse face, each cutting with at least 144 square inches, a minimum width of 3 inches, and a minimum length of 24 inches, and with a maximum waste of $33\frac{1}{3}$ per cent. Pieces in No. 2 common must yield clear cuttings free from sapwood on one face, at least 2 inches wide, and with a minimum of 72 square inches, with a maximum waste of 50 per cent. No. 3 common must be at least 3 inches wide and 4 feet long and must be capable of yielding sound cuttings at least $1\frac{1}{2}$ inches wide, and with a minimum of 36 square inches, with a maximum waste of 75 per cent. When steamed walnut is specified, restrictions as to sap-

wood do not apply. Standard thicknesses for walnut are as follows (in inches): $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, 5, $5\frac{1}{2}$, and 6.

As walnut logs are generally not purchased according to certain specified grades, the prices for logs of different size and quality are quite indefinite. The value of each log is, as a rule, determined by the log buyer.

The representative prices of Arkansas logs, on the track at Kansas City, in 1913, based on a freight rate of 20 cents, or about $18 to $20 a thousand board feet, are shown in Table 7.

TABLE 7.

Diameter (inches).	Price, 1,000 board feet.
12 to 13	$25
14 to 15	35
16 to 17	45
18 to 19	57
20 to 21	65
22 to 23	85
24 to 25	110
26 to 27	145
28 and up	210

The average shipment brought about $60 a thousand feet, which is approximately the average price for 20-inch logs. Just before the war walnut logs were costing the large walnut operators between $50 and $60 a thousand board feet, on the average, at the factory.

The prices paid for several years past by one firm for three different grades of walnut logs at the factory are given in Table 8:

TABLE 8.

Diameter (inches).	No. 1 (practically clear, generally 16 inches and over).	No. 2 (medium quality).	No. 3 (poor quality).
10 to 14	$50	$35	$25
15 to 17	55	40	30
18 to 20	60	45	33
21 to 22	70	50	35
23 to 24	80	55	40
25 to 26	90	60	45
26 to 28	105	75	50
29 and up	115	85	55

During the war, in order to make more timber available, higher prices were paid for walnut logs than had been paid before. The War Industries Board of the Council of National Defense drew up a schedule of fair prices for walnut logs and stumpage as shown in Table 9:

TABLE 9.

Diameter (inches).	Prices of black walnut logs, 8 feet long and over, f. o. b. cars at railroad.		Equivalent value for standing timber.	
	Minimum, 1,000 board feet.	Maximum, 1,000 board feet.	Minimum, 1,000 board feet.	Maximum. 1,000 board feet.
12 to 14	$45	$55	$20	$35
15 to 16	55	65	30	45
17 to 18	65	75	40	50
19 to 20	75	85	50	60
21 to 22	85	95	60	70
23 to 24	95	105	70	80
25 to 26	105	115	80	90
27 to 28	115	125	90	100
29 to 30	125	135	100	110
31 and up	135	150	110	120

Prices paid for walnut generally averaged a little higher than this, especially toward the close of the war, except for the more inaccessible and scattered timber. The average stumpage price was around $50 a thousand board feet, the price usually paid for logs 16 inches in diameter.

The cost of getting stumpage to the mill yard varies greatly, depending on the distance to mill and the extent to which trees are scattered, as well as on some other conditions. During the war the range in costs was about as given in Table 10:

TABLE 10.

Buying	per 1,000 board feet, log scale	$5–$10
Felling	do	5– 10
Hauling and loading on cars	do	15– 30
Freight	do	15– 20
Total		40– 70

The high cost of buying and felling is due to the widely scattered growth. If good stands of walnut are available these two items of cost should be only about half those given. If the average stumpage price of $50 is added to the sum of these costs the total cost becomes $90 to $120 a thousand at the mill yard.

For several months following the close of the war, prices paid for walnut timber ranged about the same as during the war; but a better quality of logs was purchased, and logs 14 inches and under in diameter were not taken unless they were of very good quality. Reports from walnut operators on prices paid for logs during this period show an average cost at the mill of $75 a thousand board feet, log scale, for logs 16 inches in diameter, as against a cost of $90 to $120 a thousand board feet for logs of the same size purchased during the war. The average cost for logs of all sizes was $90 a thousand board feet. This shows that the average size of logs purchased was greater than that of those purchased during the war. More recently prices paid for walnut logs have increased greatly, following much higher prices for walnut lumber and other hardwoods. These greatly increased prices are due in large part to higher logging costs.

The prices given above for large logs can not be considered as lumber-log prices, since the larger sizes, particularly if the logs are clear, are used for veneer. As lumber and veneer logs are generally purchased together, the above average for all logs does not represent average prices paid for lumber logs. It is not practicable, however, to attempt to give prices for lumber logs alone.

Table 11 shows the average value of walnut lumber at the mills, by States, for the years for which these data are available. These figures show a marked rise in price since 1911.

In Table 12 are given the average wholesale prices of walnut lumber in various markets, based on actual sales for the years 1908 to 1912, inclusive, the only years for which these data are available. These figures show a steady increase in the price of firsts and seconds grade for these years.

Table 13 gives the prices of 4/4 firsts and seconds, of 4/4, 6/4, and 8/4 No. 1 common, and of 4/4 No. 2 common, from 1912 through the first half of 1920, in different markets, as published by the Lumbermen's Bureau. These figures show a general rise in price, particularly since 1915, and a marked rise since the middle of 1919.

For comparison with other native cabinet woods, Table 14 was prepared from the same source. It gives prices of walnut, red gum, plain white oak, and birch, and uses 4/4 No. 1 common, at Chicago, as a basis.

TABLE 11.—*Average value of walnut lumber per 1,000 board feet f. o. b. mills, by States, for different years.*

	1899	1904	1907	1908	1909	1910	1911	1915	1916	1917	1918
United States	$36.49	$45.64	$43.31	$42.53	$42.79	$34.91	$31.70	$48.47	$42.38	$72.99	$77.60
Missouri	42.59	47.60	48.30	50.73	42.39	33.39	32.39	48.78	46.33	177.77	85.92
Indiana	39.18	40.56	44.87	43.93	42.66	37.74	34.86	44.83	43.95	61.92	80.99
Ohio	42.68	50.95	47.10	46.08	55.33	38.08	32.38	48.21	40.63	44.51	89.07
Tennessee	19.27	35.27	34.62	36.39	37.37	32.88	29.37	44.28	36.87	55.82	58.04
Kansas	17.19	30.00	.....	.....	30.00	35.00	.....	.....	68.00	84.86	59.33
Illinois	33.43	72.98	51.28	54.38	54.53	36.76	33.75	62.59	44.46	115.21	82.83
Iowa	35.88	33.37	36.67	27.14	34.20	36.58	30.45	45.76	57.26	58.91	78.71
Kentucky	30.24	32.88	37.59	38.54	35.94	31.88	28.67	45.36	37.18	44.05	68.48
Virginia	30.39	35.09	34.88	33.43	33.63	30.60	32.33	27.89	23.66	31.53	51.23
West Virginia	25.46	31.46	32.54	31.02	29.98	32.00	31.57	31.70	34.68	37.70	51.30
Arkansas	20.81	40.91	37.59	49.84	41.65	37.30	28.33	33.22	29.79	51.06	64.73
North Carolina	27.85	20.09	37.75	25.97	32.39	31.29	23.95	27.04	28.55	32.85	34.93
Louisiana	80.00	.....	.....	.....	.....	.....	.....	.....	40.00	.....	100.00
Pennsylvania	37.28	.....	39.01	37.17	36.94	30.38	21.47	36.39	30.09	41.55	40.25
Michigan	47.34	61.67	42.80	40.53	36.60	38.84	36.25	35.58	44.06	48.00	46.03
Oklahoma	38.29	52.03	41.21	24.50	25.40	22.44	25.67	29.62	23.75	32.54	59.68
New Jersey	33.04	.....	45.00	35.36	51.12	51.00	.....	32.00	41.25	60.00	50.00
Maryland	27.65	49.50	45.40	39.76	33.45	37.59	25.00	31.47	19.70	30.45	65.33
Wisconsin	12.26	18.13	23.00	23.00	26.67	40.00	22.33	54.50	44.00	65.71	43.88
New York	36.77	40.15	.....	.....	.....	.....	.....	33.70	32.33	36.00	53.00
Alabama	27.31	40.00	35.83	40.19	43.57	34.47	24.86	31.75	44.07	32.47	42.00
Georgia	12.00	.....	45.00	39.25	19.67	41.50	22.75	29.33	29.75	32.14	30.00
Mississippi	.....	.....	50.00	46.69	57.18	35.00	.....	.....	31.98	30.00	52.06
Massachusetts	41.67	16.21	29.33	21.26	21.37	17.00	18.67	18.33	21.61	24.67	23.25
Vermont	.....	.....	17.00	20.00	18.00	.....	.....	23.00	44.80	45.00	28.13
Connecticut	25.81	28.77	30.00	20.00	20.24	24.36	23.75	20.00	27.11	20.00	30.00
Texas	16.03	33.33	40.00	25.00	30.89	.....	.....	50.00	30.00	35.00	40.33
Rhode Island	28.00	.....	.....	19.52	24.85	.....	.....	.....	29.00	28.82	40.80
Delaware	60.00	.....	.....	55.00	27.50	.....	.....	25.00	.....	.....	50.00
South Carolina	.....	.....	.....	.....	29.00	37.25	27.33	40.00	35.74	25.00	35.00
Minnesota	20.00	.....	.....	65.00	35.00	42.50	.....	.....	22.50	25.00	35.00
New Hampshire	.....	.....	.....	21.00	20.00	19.00	.....	.....	27.00	.....	30.00
Maine	.....	.....	.....	.....	.....	.....	.....	.....	25.00	.....	.....
California	36.67	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 12.—*Average wholesale prices of walnut lumber per 1,000 board feet, in various markets, based on actual sales made f. o. b. each market.*

	1908	1909	1910	1911	1912
Boston:					
Firsts and seconds 4/4	$105.00	$107.00	$105.00	$108.12	$112.00
No. 1 common 4/4	.....	58.00	62.25	63.25	60.75
No. 2 common 4/4	.....	38.00	.....	40.75	37.38
Philadelphia:					
Firsts and seconds 4/4	.....	110.00	.....	102.50	.....
No. 1 common 4/4	.....	60.00	.....	57.50	.....
No. 2 common 4/4	.....	35.00	.....	33.25	.....
Buffalo:					
Firsts and seconds 4/4	105.00	105.50	.....	103.38	114.12
No. 1 common 4/4	63.67	61.25	.....	55.38	57.88
No. 2 common 4/4	33.17	33.50	.....	31.62	31.75
Cincinnati:					
First and seconds 4/4	90.25	92.25	92.17	93.33	98.50
No. 1 common 4/4	50.50	50.14	48.33	51.08	51.42
No. 2 common 4/4	28.50	27.50	25.67	26.00	30.08
Chicago:					
First and seconds 4/4	.....	98.50	.....	.....	.....
No. 1 common 4/4	.....	55.50	.....	.....	.....
No. 2 common 4/4	.....	.....	.....	.....	.....
Memphis:					
Firsts and seconds 4/4	.....	.....	95.00	.....	.....
No. 1 common 4/4	.....	.....	50.00	.....	.....
No. 2 common 4/4	.....	.....	30.00	.....	.....
Minneapolis:					
Firsts and seconds 4/4	.....	100.00	.....	.....	.....
No. 1 common 4/4	.....	60.00	.....	.....	.....
No. 2 common 4/4	.....	35.00	.....	.....	.....
Denver: Firsts and seconds 4/4	.....	120.00	.....	.....	.....
San Francisco:					
Firsts and seconds 4/4	190.50	193.00	190.00	.....	.....
No. 1 common 4/4	147.50	140.56	140.00	140.00	.....
Los Angeles: Firsts and seconds 4/4	150.00	160.00	.....	.....	.....
Tucson: Firsts and seconds 4/4	.....	172.50	.....	.....	.....
Kansas City:					
Firsts and seconds 4/4	.....	.....	.....	97.50	.....
No. 1 common 4/4	.....	.....	.....	43.50	.....
No. 2 common 4/4	.....	.....	.....	22.50	.....
St. Louis:					
Firsts and seconds 4/4	.....	.....	.....	90.25	.....
No. 1 common 4/4	.....	.....	.....	50.25	.....
No. 2 common 4/4	.....	.....	.....	27.25	.....

TABLE 13.—*Average wholesale prices per 1,000 board fe et of different grades and thicknesses of walnut lumber at representative markets for different years and quarter years.*

	1912	1913	1914	1915	1916	1917				1918				1919				1920	
						1st quarter.	2d quarter.	3d quarter.	4th quarter.	1st quarter.	2d quarter.	3d quarter.	4th quarter.	1st quarter.	2d quarter.	3d quarter.	4th quarter.	1st quarter.	2d quarter.
New York:																			
First and seconds 4/4	$116.00	$116.00	$115.40	$114.00	$122.75	$122.67	$122.00	$127.00	$147.00	$155.67	$155.17	$157.50	$157.50	$157.50	$157.50	$171.33	$188.00	$233.00	$307.50
No. 1 common 4/4	58.55	61.00	60.40	59.00	63.75	63.33	62.00	67.00	70.33	70.67	70.17	72.50	72.50	72.50	73.17	88.67	114.67	180.33	210.83
No. 1 common 6/4	65.14	71.50	70.90	69.50	74.25	73.67	72.00	77.00	80.33	80.67	80.17	82.50	82.50	82.50	83.17	95.00	124.67	190.33	222.50
No. 1 common 8/4	67.14	76.50	75.90	74.50	79.25	78.67	77.00	82.00	85.33	86.33	85.17	87.50	87.50	87.50	88.17	107.17	134.67	203.67	234.17
No. 2 common 4/4	36.00	36.00	35.40	34.00	37.75	37.67	37.00	40.00	43.33	40.67	37.17	39.50	39.50	39.50	39.50	43.17	51.33	94.33	110.83
Buffalo:																			
First and seconds 4/4	113.75	113.75	113.15	111.75	120.75	120.33	119.00	124.00	144.00	152.67	152.17	154.50	154.50	154.50	154.50	168.33	185.00	230.00	304.50
No. 1 common 4/4	55.57	57.75	57.15	55.75	69.75	60.33	59.00	64.00	67.33	67.67	67.17	69.50	69.50	69.50	70.17	82.33	101.67	174.00	207.83
No. 1 common 6/4	62.64	69.00	68.40	67.00	71.75	71.17	69.50	74.50	77.83	78.17	77.67	80.00	80.00	80.00	80.67	92.33	121.67	187.33	219.50
No. 1 common 8/4	64.64	74.00	73.40	72.00	76.75	76.17	74.50	79.50	82.83	83.83	82.67	85.00	85.00	85.00	85.67	104.33	131.67	200.67	231.17
No. 2 common 4/4	33.75	33.75	33.15	31.75	35.75	35.33	34.00	37.00	40.33	37.67	34.17	36.50	36.50	36.50	36.50	40.50	48.83	91.50	107.83
Detroit and Grand Rapids:																			
First and seconds 4/4	114.25	114.25	113.40	112.00	120.75	120.33	119.00	124.00	144.00	152.67	152.17	154.50	154.50	154.50	154.50	167.00	180.50	[1]228.50	[1]304.50
No. 1 common 4/4	56.07	58.18	57.40	56.00	60.75	60.33	59.00	64.00	67.33	67.67	67.17	69.50	69.50	69.50	70.17	86.00	112.17	[1]177.50	[1]207.83
No. 1 common 6/4	62.89	69.18	68.40	67.00	71.75	71.00	69.00	74.00	77.33	77.67	77.17	79.50	79.50	79.50	80.17	91.67	121.17	[1]187.17	[1]219.50
No. 1 common 8/4	64.89	75.55	75.40	74.00	78.75	77.33	74.00	79.00	82.33	83.33	82.17	84.50	84.50	84.50	85.17	103.83	131.17	[1]200.50	[1]231.17
No. 2 common 4/4	34.25	34.18	33.40	32.00	35.75	35.33	34.00	37.00	40.33	37.67	34.17	36.50	36.50	36.50	36.50	40.50	48.83	[1]91.50	[1]107.83
Chicago:																			
First and seconds 4/4	113.75	113.75	113.22	112.00	120.75	119.67	117.00	122.00	142.00	150.67	150.33	153.50	153.50	153.50	153.50	167.00	183.50	228.17	302.50
No. 1 common 4/4	55.57	57.75	57.22	56.00	60.75	59.67	57.00	62.00	65.33	65.67	65.17	67.50	67.50	67.50	68.17	84.00	110.17	175.50	205.83
No. 1 common 6/4	62.64	69.00	68.40	67.00	71.75	70.33	67.00	72.00	75.33	75.67	75.17	77.50	77.50	77.50	78.17	90.00	119.67	185.33	217.50
No. 1 common 8/4	64.64	74.00	74.00	74.00	78.75	76.67	72.00	77.00	80.33	81.33	80.17	82.50	82.50	82.50	83.17	102.17	129.67	198.67	229.17
No. 2 common 4/4	33.75	33.75	33.22	32.00	35.75	34.67	32.00	35.00	38.33	35.67	32.17	34.50	34.50	34.50	34.50	38.50	46.83	89.50	105.83
Cincinnati:																			
First and seconds 4/4	110.00	110.00	109.40	108.00	116.75	117.00	116.33	121.00	141.00	149.67	149.00	150.50	150.50	150.50	150.50	164.33	181.00	225.75	300.00
No. 1 common 4/4	51.82	54.00	53.40	52.00	56.75	57.00	56.33	61.00	64.33	64.67	64.00	65.50	65.50	65.50	66.17	81.67	107.67	173.08	203.33
No. 1 common 6/4	58.64	65.00	64.40	63.00	67.75	68.00	66.67	71.00	74.33	74.67	74.00	75.50	75.50	75.50	76.17	88.00	117.67	182.08	215.00
No. 1 common 8/4	60.64	70.00	70.00	70.00	74.75	75.00	72.33	76.00	79.33	80.33	79.00	80.50	80.50	80.50	81.17	100.17	127.67	196.42	226.67
No. 2 common 4/4	30.00	30.00	29.40	28.00	31.75	32.00	32.00	35.00	38.33	35.67	32.00	33.50	33.50	33.50	33.50	36.50	44.33	87.08	103.33
St. Louis:																			
First and seconds 4/4	108.00	108.00	107.40	106.00	114.75	115.00	114.33	119.00	139.00	147.67	147.17	148.50	148.50	148.50	148.50	163.00	180.00	224.33	298.33
No. 1 common 4/4	54.59	56.50	56.35	56.00	60.75	61.00	56.33	59.00	62.33	62.67	62.17	63.50	63.50	63.50	64.17	80.33	106.67	171.67	201.83
No. 1 common 6/4	63.14	69.50	68.90	67.50	72.25	72.50	66.83	69.00	72.33	72.67	72.17	73.50	73.50	73.50	74.17	86.33	116.17	181.50	213.50
No. 1 common 8/4	64.14	73.50	72.75	71.00	75.75	75.00	71.00	74.00	77.33	78.33	77.17	78.50	78.50	78.50	79.17	98.50	126.17	194.83	225.17
No. 2 common 4/4	30.00	30.00	29.40	28.00	31.75	32.00	30.67	32.00	35.33	32.67	29.17	30.50	30.50	30.50	30.50	34.83	43.33	85.67	101.83
Kansas City:																			
First and seconds 4/4	100.00	100.00	99.40	98.00	106.75	107.00	109.00	115.00	135.00	143.67	143.17	143.50	143.50	143.50	143.50	157.33	174.00	224.33	301.50
No. 1 common 4/4	48.00	49.50	48.90	47.50	52.25	52.50	50.83	55.00	58.33	58.67	58.17	58.50	58.50	58.50	59.17	74.67	100.67	171.67	204.83
No. 1 common 6/4	52.00	57.00	56.40	55.00	59.75	60.00	60.00	65.00	68.33	68.67	68.17	68.50	68.50	68.50	69.17	80.33	109.67	181.33	216.50
No. 1 common 8/4	54.00	62.00	61.40	60.00	64.75	65.00	65.00	70.00	73.33	74.33	73.17	73.50	73.50	73.50	74.17	92.50	119.67	194.67	228.17
No. 2 common 4/4	25.00	25.00	24.40	23.00	26.75	27.00	25.67	28.00	31.33	28.67	25.17	25.50	25.50	25.50	25.50	29.17	37.33	85.67	104.83

[1] Grand Rapids only.

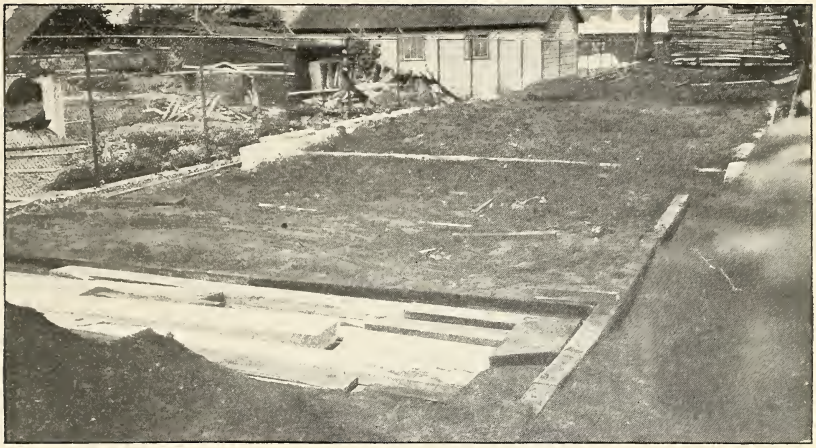


FIG. 1.—STEAMING PITS FOR WALNUT LUMBER.

In the foreground the lumber is piled in one of the compartments preparatory to being covered and steamed. The other compartments are filled with lumber, except at the extreme right in the background, where the steamed lumber has just been lifted out.

FIG. 2.—WASTE WALNUT, SUITABLE FOR MANUFACTURE INTO SMALL ARTICLES, BUT GENERALLY USED FOR FUEL.

TABLE 14.—*Average wholesale prices per 1,000 board feet of different cabinet woods for different years and quarter-years, based on 4/4-inch, No. 1 common grade at Chicago.*

Year.	Walnut.	Red gum.	Plain white oak.	Birch.
1912	$55.57	$26.18	$33.11	$25.00
1913	57.75	24.91	37.95	28.50
1914	57.22	22.40	34.60	26.70
1915	56.00	21.71	32.33	25.00
1916	60.75	26.38	35.12	27.71
1917:				
First quarter	59.67	30.00	35.67	30.67
Second quarter	57.00	33.67	37.67	37.33
Third quarter	62.00	38.00	40.33	40.67
Fourth quarter	65.33	37.67	37.00	39.33
1918:				
First quarter	65.67	39.00	40.33	36.00
Second quarter	65.17	39.67	41.83	38.50
Third quarter	67.50	42.50	46.67	40.50
Fourth quarter	67.50	41.83	46.67	40.50
1919:				
First quarter	67.50	40.67	46.67	38.50
Second quarter	68.17	45.00	51.00	37.83
Third quarter	84.00	73.00	72.33	48.50
Fourth quarter	110.17	90.50	85.67	56.33
1920:				
First quarter	175.50	157.17	133.00	115.00
Second quarter	205.83	156.33	153.[illegible]3	148.33

METHODS AND COST OF LOGGING.

Because of the scattered growth, methods of logging walnut timber differ from those employed for timber found in large quantities. Walnut is often cut by the owner and hauled to the railroad; sometimes it is cut and hauled by a local representative of the mill purchasing it or by the independent buyer with his own teams or truck. Hauling logs by large automobile trucks long distances to the railroad or mill is becoming quite a common practice. Large mills sometimes employ a regular corps of logging crews, trucks, and teams, which cover different walnut areas systematically, picking up all available walnut timber as they go. During the war some firms covered the ground very thoroughly; at first they sent out men to locate suitable timber, then they sent buyers to purchase it, and later they sent cutters, teams, and trucks to fell it and load it at the railroad or to haul it to the mill if that was not too far distant. Some firms that do their own logging have trucks specially equipped with cables and windlass, with which logs may be dragged out of steep gullies and other difficult places and loaded. Three hundred board feet of average-sized logs weigh about 2,500 pounds and are considered a large wagonload. A motor truck should carry up to four times that amount and make much more frequent trips.

As walnut splits somewhat easily it is necessary to exercise unusual care in felling the tree, especially if there is a large crotch, for the split may extend a long distance below the fork into the large trunk and cause considerable loss.

The cost of logging walnut is higher than that of logging other species, because it is often a case of picking up a few trees or only one on a farm. The cost also varies greatly with the amount of timber in any one locality. West of the Mississippi, where there are comparatively good stands and the best timber has not been removed, the trees can be felled and sawed into logs for $2 to $5 a thousand board feet, log scale. In the East, where the trees are much scattered, this cost may run as high as $8 or $10 a thousand. Digging up stumps is expensive. It generally takes a crew of five men to dig up and dress an average of two stumps a day.

The cost of hauling to the railroad varies greatly with the length of haul, the character of the country, the condition of the roads, and the equipment used. With a team and fairly good hauling conditions it generally costs $15 to $30 a thousand board feet for a 5 to 10 mile haul, or at the rate of $3 a mile. A general average would probably be about $20 a thousand for a 7 to 8 mile haul. If the timber is much scattered and the country rough, the cost will amount to $4 a thousand for a mile. A team can usually make but one trip a day, hauling about 300 board feet of logs for 10 miles over fair roads. A large automobile logging truck generally makes two round trips a day, carrying about 1,000 feet over a 20-mile haul. On this basis the truck will do 12 times as much work as one team. The cost of trucking depends to a very large extent upon the investment and expense of upkeep, and will vary greatly with the equipment used. The cost of loading logs on cars is generally figured at $2.25 to $2.50 a thousand board feet.

WASTE.

Walnut logs are utilized very closely for lumber. Material coming under the head of waste consists of saw kerf or sawdust, slabs and edgings, very low-grade and defective lumber, and relatively clear pieces of small dimension. The waste caused by the saw kerf may be reduced to a minimum by using a band saw instead of a circular saw. A timber so valuable and so scarce as walnut should not be sawed with a circular saw, and, because less waste results, small sawmills often ship their walnut logs to a large mill that has a band saw. The sawdust is generally used for fuel. It is used also, instead of hickory, to a considerable extent for smoking meats and, with the exception of hickory, is said to be the best wood available for the purpose. Large packing houses use great quantities of walnut sawdust in this way, but the demand seems to be very small in comparison with the supply available. Sawmill operators have endeavored to find other uses for walnut sawdust, such as for sweeping compounds. The dark color of walnut seems to bring it into

disfavor for this use, probably because of the mistaken idea that the dark sawdust is not clean. Slabs and edgings are useful only for fuel and are generally burned in the steam boilers. At some mills located near large cities a good trade has been started up in walnut cordwood. This waste, together with pieces too low in grade or too small in size to be merchantable, is usually sold by the wagonload for about $1.25 or $1.50 a load, which is equivalent to about $3.50 a cord. Much very low-grade and defective lumber that is marketable in normal times has not been salable because of the large accumulations made during the war. This class of material may be in demand for cheap and low-grade lumber when such stocks become less plentiful. A vast quantity of small sound portions of walnut accumulated in the process of manufacturing gunstock blanks from the flitch, and from these portions many clear pieces may be cut. Some of this stock has been disposed of to manufacturers of such small novelties as air rifles, but the market is limited, and immense piles of this material must be used for fuel. (Pl. IV, fig. 2.)

Some mills convert their low-grade and small-dimension material into dimension stock. This, however, does not seem to be generally successful with walnut, on account of the large number of sizes demanded, and these can not be produced without considerable waste. Manufacturers complain that for carefully manufactured clear stock they receive much less than for No. 1 common lumber; whereas they should receive a price equal to that of the firsts and seconds grade. Factory managers claim, on the other hand, that much waste in the use of dimension stock is caused by too close cutting to the finished size, by warping and checking, and by the presence of serious defects which can not be cut out. Theoretically, the manufacture of low-grade material into dimension sizes should be a success economically, provided the sizes are made to meet factory requirements. Thus, before the war, a chair factory would purchase No. 1 common black walnut lumber for, say, $65 a thousand, kiln-dry it for approximately $6, and cut it up at a cost of $10 to $15 a thousand, making a total cost of about $83. Since the average waste in manufacture amounts to about 25 per cent, the original thousand board feet would be reduced to about 750 board feet. This would make the material cost 11 cents a board foot, or $110 a thousand, after it had been seasoned and cut up. It would seem that a good grade of dimension material should bring a price by the thousand board feet at least equal to the price which high-grade lumber would bring. As a matter of fact, managers of many furniture factories prefer to buy the lumber and cut their dimension sizes from it, for they have a large number of different designs which change from year to year, and they might suffer much waste in buying dimension sizes. Therefore, the lumber

manufacturer generally cuts dimension material merely to use his low-grade lumber and get a return from stock which is difficult to market. There has been and still is a wide range in selling prices for dimension material. A price as low as $30 a thousand board feet, before the war, was reported for small clear stock cut from No. 2 common, and as high as $80 for chair stock cut from waste. Differences in price depend to a large degree on the quality of the stock. Notwithstanding the many objections to the use of dimension material, its manufacture in standard sizes in large quantity is successfully carried on. Dimension stock should be clear of defects and first class in every way. Kiln-dried or thoroughly air-dried stock is much more satisfactory than green or partially seasoned material. Low prices and lack of demand for dimension materials are, in large part, the result of the manufacture of improperly seasoned, scant, and defective stock.

Walnut-lumber manufacturers now often recut such low-grade lumber as No. 2 common, for which there is a relatively small demand, into smaller, less-defective pieces, which are classed in a higher standard lumber grade or may be sold as a special grade of stock that is narrow or short or both narrow and short. This remanufacture is generally applied to the lower grades of 4/4, 6/4, and 8/4, and to a considerable extent is taking the place of dimension manufacture. This method is advantageous in that the factories may saw their required pieces from this material, and the waste that might result from the purchase and use of dimension stock is often avoided. Some lumber manufacturers are disposing of their low-grade walnut by running factories in connection with their sawmills, in which they utilize the small sizes of material in making such products as phonograph cabinets and various kinds of boxes and novelties.

VENEER.

Because it is so easily worked with tools, walnut is an excellent wood for manufacture into veneer. The pleasing appearance due to its good color, the different figured effects and the variety of tones and patterns which can be obtained from different logs, and its excellent finishing qualities combine to make it one of the most satisfactory native woods for fine cabinet veneer. The best-growth logs are generally sound, well rounded in cross section, straight, and with little taper. Our wild cherry is also a good cabinet veneer wood, but it lacks the figure of walnut, and even the best timber generally has many small defects. Walnut, mahogany, and cherry are said to be the most satisfactory cabinet woods for making sliced veneer, because they are so easily cut with the veneer knife and make a

smooth sheet without splintering. Moreover, the veneer warps very little in drying, glues very satisfactorily, and after it is made into panels does not shrink or swell excessively under varying moisture conditions.

PRODUCTION.

Data on the output of walnut in the form of veneer are available from reports of the Census Bureau for the years 1904 to 1911, inclusive. The amounts of walnut logs used in different years are given in Table 15, and also the cost of the logs per thousand board feet, log scale, where reported. Approximately 95 per cent of the total amount for the years 1906 to 1909 was used for rotary veneer. Reports for those years are given by States and are shown in Table 16.

TABLE 15.—*Walnut used in different years in the manufacture of veneer, from reports by the Bureau of the Census.*

Year.	Thousands of board feet, log scale.	Cost per 1,000 board feet.
1904	[1] 2,250	.....
1905	1,725	.....
1906	5,121	$67.76
1907	3,952	70.39
1908	5,176	60.53
1909	2,400	69.36
1910	2,724	.....
1911	4,121	.....

[1] This figure was obtained by using an average converting factor of 12 square feet of veneer to each board foot, log scale, derived from reports for the years 1905–1907, as reports for 1904 were only on veneer produced.

TABLE 16.—*Amounts of walnut logs consumed in the production of veneer, by States, for different years, in thousands of board feet, log scale.*

State.	1906	1907	1908	1909
California	.....	.....	3	2
Delaware	.....	.....	.....	10
Illinois	2,329	2,590	2,813	1,492
Indiana	1,115	696	2,120	310
Kentucky	23	40	37	19
Maryland	400	200	51	51
Massachusetts	4	.....	4	1
Michigan	3	6	2	20
Missouri	.....	.....	.....	200
New Jersey	1	.....	.....	.....
New York	35	64	12	50
Ohio	1,175	203	105	181
Pennsylvania	.....	100	.....	.....
Tennessee	.....	30	7	.....
Virginia	18	13	6	6
West Virginia	18	10	16	50
Total	5,151	3,952	5,176	2,400

Recent reports obtained from practically all of the large manufacturers of walnut veneer in the United States show a consump-

tion of 3,296,000 board feet, log scale, of logs in 1917, with a production of 64,654,000 square feet of veneer, and an estimated consumption of about 5,615,000 board feet of logs in 1919, with a production of about 111,200,000 square feet of veneer. These figures are given by States in Table 17. About 50 per cent of the total amount is straight sliced and the other 50 per cent is about equally divided between rotary proper and stay-log rotary. Of the total amount of veneer produced, approximately one-half is plain and one-half figured. During 1918 the cutting of walnut veneer, except highly figured stock from cross-grained wood, was prohibited by the War Department. Near the close of the year the cutting of walnut veneer was resumed; and the great demand that arose because of depleted stocks, together with the large supply of walnut logs on hand that had been purchased to fulfill Government war orders, accounts for the marked increase in production shown for 1919. It is also estimated that the 1920 walnut veneer production will be in excess of 100,000,000 square feet. The increase in the production of veneer in recent years is greater than the log-consumption figures indicate, for the amount of veneer obtained now is much greater from the same number of feet, log scale, largely because of the cutting of thinner veneer. For instance, in 1906, from 5,121,000 board feet of logs, 67,184,000 square feet of veneer was produced, or 13 square feet of veneer to 1 board foot of log; but in 1917 and 1919 the ratio of square feet of veneer to board feet of logs, log scale, was about 20 to 1. The estimated 1919 production was nearly double the reported production of 1906, and the estimated log consumption of 1919 was only about 9 per cent greater than the reported consumption of 1906.

TABLE 17.—*Amounts of walnut logs consumed in the production of veneer for 1917, and estimated consumption in 1919, by States.*

States.	Thousands of board feet.	
	1917	1919
Indiana	1,200	2,250
Illinois	789	650
Ohio	190	835
Michigan, West Virginia, Maryland	636	1,130
Kansas, Missouri	481	750
Total	3,296	5,615

MANUFACTURE.

Walnut veneer is produced almost altogether by slicing, but small amounts are still sawed for special purposes. Sliced veneer is made by two processes—the rotary method in which the timber is rotated

against the knife, and the straight-slice method in which the timber moves in a straight line.

Rotary-cut process.—This process has been used extensively for making veneer. It is still the method in most common use, for it has the advantage of a low cost of production.

Walnut veneer logs are sawed into the lengths required for the veneer that is to be cut. These sections are put in hot water, generally over night; hard material may require a night and a day, or even two nights and a day. Each log section is then taken out and, after the bark is removed, revolved in the rotary machine, which is constructed like a lathe. The knife is constantly advanced, the advance for each revolution of the log corresponding to the thickness of the veneer. The veneer is usually torn off where a defect occurs, often at each revolution. Logs may be sliced down to a diameter of 6 to 8 inches, depending on the machine. Some specially constructed machines cut down to a diameter as small as 4 inches. The figure in this veneer is made by the growth rings, and, since the slicing is done in the direction of these rings, a veneer with a large coarse figure is the result. Hence only the lowest grade of logs is cut in this manner. Moreover, a considerable part of the heartwood, and usually the most valuable part, is wasted in the core. If the center of the log is defective, there is some advantage in slicing by the straight rotary process.

A variation of the rotary is the half-round process, by which the log is set somewhat off the center, and veneer is cut only part way around the log. This method is most commonly used with small logs in which there is a small amount of heartwood. The veneer may be sliced from the heartwood in this way, whereas by the straight rotary process little or no veneer can be obtained from the heartwood of small logs. If they are trimmed, successive sheets may be matched up for panel work. After the slicing of two sides of the log, the rest may be straight sliced and will yield quartered stock provided the central portion of the log is not defective. If the log is not sufficiently clear for veneer, it may be made into dimension stock.

The stay-log rotary process is a development from the rotary method proper, and is now very largely used for walnut. In this process a heavy flat plate is set off center, at a distance of about 1 foot, to which the timber to be sliced is fastened. The walnut block to be sliced is in the form of a half-log, generally called a flitch, and the sapwood is largely trimmed off (Pl. V, fig. 1). Holes are then bored in this flitch to correspond with those in the plate, to which it is to be fastened with stay bolts. By this method the heartwood, which must be thrown away in the core in the straight rotary method, may be more closely utilized.

Some manufacturers cut from the "sap" side, the outside of the log (Pl. V, fig. 2), and others cut from the "heart" side or center of the log. Those who cut by the latter method do so in order to get wide heartwood stock that is at least partly quartered. This adds to its attractiveness, particularly if there is a figure in it. More of the quartered stock may thus be obtained with less waste than by the straight-slice method. It is true, as manufacturers claim who cut from the "sap" side of such flitches, that by slicing from the flat heartwood side there is considerable waste in working down to the curved surface from which a continuous sheet may be obtained. Moreover, since knots are more numerous near the center of walnut logs, the "heart" side is more likely to be defective. On the other hand, if the center of the log is clear, considerable valuable heartwood is wasted in the "dog board" when the slicing is done from the sapwood side. Although the thickness of the sapwood must first be trimmed off, and after that some narrow sheets of heartwood are cut, this method makes possible the production of wider sheets of heartwood than are obtained by cutting from the heartwood side. If the cutting is from the outside, the figure is somewhat coarse, as in the rotary method proper, but slicing from the "heart" side cuts across the growth rings and gives a striped effect. In stay-log slicing the flitch is sliced down to a thickness of about 3 inches, the piece that is left being called the "dog board." If the veneer is cut from the heartwood side, the last sheets are nearly all sapwood.

Rotary machines are generally made to take a log as long as 8 to 10 feet. Stump or "butt" wood is sliced by the rotary stay-log process, veneer being cut from the outside of the log. This is for the reason that the figure in "butt" wood runs with the outer surface of the wood. These stumps or butts are cut in half, because they can be more conveniently handled in this form.

Straight-slice process.—In this method the timber, which is first soaked, as in the rotary method, is pushed vertically against the knife with, however, a slightly oblique motion from end to end. The log lengths are usually cut in half lengthwise and prepared as in the stay-log rotary process. The cut is then made from the heartwood side. Quartered stock is, of course, obtained only near the center of the log. The coarser figure is soon reached, particularly in the middle of the sheets. The panel maker generally trims off the outside striped veneer from the central coarse figure and keeps the two separate for different uses. Very large logs are sawed lengthwise in quarters, in order to get more of the quartered veneer stock. For quartering, logs should be at least 24 inches in diameter at the small end. Logs are also prepared for straight slicing, by squaring them,

FIG. 1.—WALNUT HALF LOGS, WHICH HAVE BEEN PREPARED FOR ROTARY STAY-LOG SLICING BY TRIMMING OFF THE GREATER PART OF THE SAPWOOD.

At the butt end they are entirely heartwood.

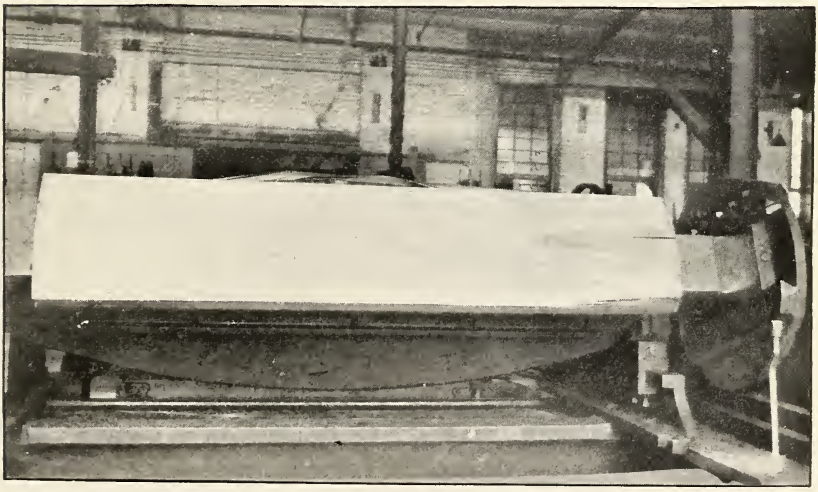


FIG. 2.—A WALNUT HALF LOG BEING SLICED FROM THE SAPWOOD SIDE BY THE ROTARY STAY-LOG PROCESS.

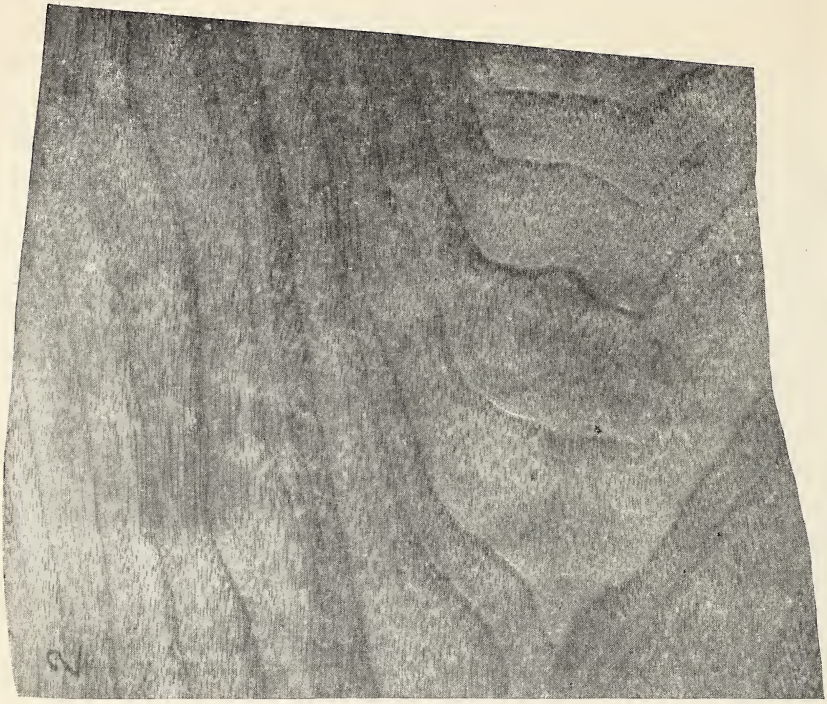


FIG. 1.—A PIECE OF PLAIN WALNUT VENEER OBTAINED BY STRAIGHT SLICING OR THE STAY-LOG ROTARY PROCESS FROM THE SAPWOOD SIDE.

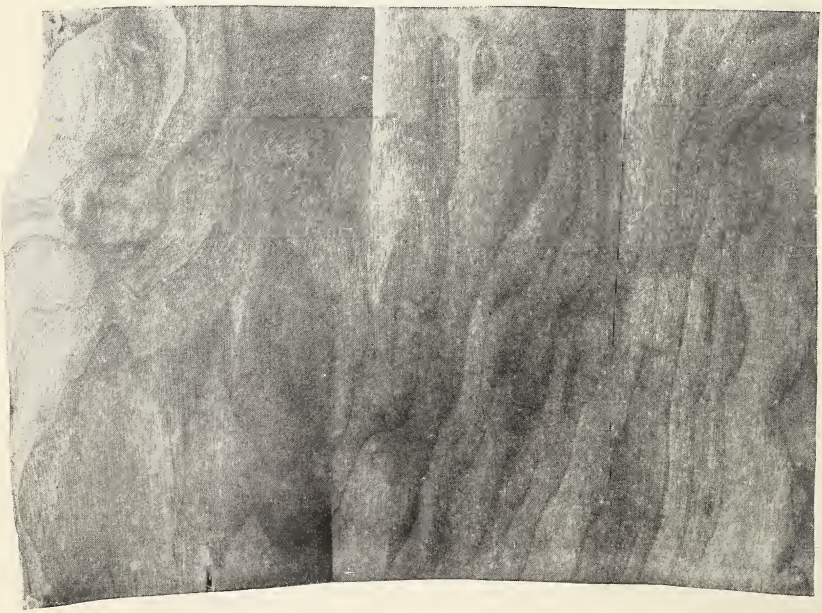


FIG. 2.—PLAIN ROTARY VENEER.

and this removes most of the sapwood. The smaller logs are handled advantageously in this way.

If there is sapwood on the edges of the veneer sheets it is trimmed off with the exception of about 1 inch. During the cutting of the sheets, the veneer from each log is piled and kept by itself, and in the same order as it came from the log. In selling this veneer, about four samples are taken from the veneer sheets from each log in different parts of the pile.

Special dimension veneer is straight sliced from clear blocks sawed from the log. These blocks are usually 4 to 6 inches thick, 1 foot wide, and 2½ to 6 feet long, and may be sliced down to a thickness of three-fourths inch. This procedure involves much less slicing, and the sheets obtained are practically clear of defects. The method is not largely used, however, and is, on the whole, adapted to making plain veneer only, because the panel maker must choose and match his figured stock from large sheets of veneer. In the usual straight-slice process the flitch is so clamped in the machine that it may be cut down to a thickness of about 2 inches. Most slicers are made to take flitches as long as 10 to 12 feet. The longest slicer will take a flitch about 16 feet in length. These machines for cutting cabinet-wood veneers are built very heavy, in order that a smooth, clean cut of uniform thickness may be made.

Sawed veneer.—Little sawed walnut veneer is manufactured. It is claimed that the sawed veneer is of a higher grade than the sliced. In the manufacture of sawed veneer the log is squared, and long sheets, usually one-twentieth inch in thickness, are sawed from it with a fine-toothed saw. Highly figured stock, including "butt" wood, is also sawed for veneers. High-grade sawed walnut veneer is used principally in Pullman cars. The highest grade is used in private railway cars. The plain veneer is used mainly for door stiles, rail stock, and table tops. This veneer is generally about one-sixteenth to one-eighth inch thick, and is used because of the greater wear to which such stock is subjected.

Burls.—Walnut burls are made into veneer by special methods of handling that depend on the size and form of burl, the quality of wood, and the kind of figure. The burl is first cut into several pieces, as an apple is cut, and may then be made into veneer by sawing, straight slicing, or rotary slicing. The kind of product and its value depend very largely upon the way in which it is handled. To get the most out of a burl requires much care and experience.

Thickness of veneer.—The most common thickness for walnut veneer at the present time is one twenty-eighth inch. Some firms use one-thirtieth inch, and thus make more veneer from a given quantity

7434°—20——4+5

of wood. Such highly figured pieces as burls are usually cut one-thirtieth inch thick. There seems to be a tendency on the part of panel makers to use thicker veneer of about one-twentieth inch. Although this veneer costs more, the makers figure that it is more profitable in the end; for with the thicker veneer almost no waste results from the rejection of panels that have been sanded through. Furthermore, the panels may be sanded more rapidly, and this is a particular advantage on account of the present high cost of labor. One-twentieth inch was formerly the common thickness for sliced veneer, but the thickness has been reduced, as walnut has become more scarce and higher in price. Sawed walnut veneer is usually one-eighth or one-sixteenth inch thick. Figured stock is usually sawed one-sixteenth inch thick.

Yield by different methods.—Exact data are difficult to obtain on the yield of veneer from logs of different sizes, because the different processes are varied to suit each log. Moreover, there are wide differences in the quality of different logs. Average yields may be calculated, however, from practically clear logs, with deductions of the average amount of waste in that part of the log from which, in commercial practice, merchantable veneer is produced. Table 18 gives in terms of veneer one twenty-eighth inch thick the calculated volumes to the linear foot of logs of different diameters. Table 19 gives the average thickness of sapwood and diameter of heartwood for logs of different diameters. In the calculations of yield, a larger allowance for sapwood is made than is shown in this table, for the reason that the sapwood is often of irregular thickness and therefore a greater waste is caused than the actual thickness of sapwood indicates.

TABLE 18.—*Theoretical volumes, in terms of one twenty-eighth inch veneer, of logs of different diameters, per linear foot of log.*

Diameter log (inches).	Sq. ft., $\frac{1}{28}''$ veneer.	Diameter log (inches).	Sq. ft., $\frac{1}{28}''$ veneer.
12	264	22	887
13	310	23	969
14	359	24	1,056
15	412	25	1,145
16	469	26	1,239
17	530	27	1,336
18	594	28	1,437
19	662	29	1,541
20	733	30	1,649
21	808		

TABLE 19.—*Average width of sapwood and diameter of heartwood, of walnut logs of different diameters.*

Diameter inside bark.	Single width of sap.	Diameter of heart.	Diameter inside bark.	Single width of sap.	Diameter of heart.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
6	0.8	4.4	19	1.6	15.8
7	.8	5.4	20	1.7	16.6
8	.9	6.2	21	1.7	17.6
9	1.0	7.0	22	1.8	18.4
10	1.0	8.0	23	1.8	19.4
11	1.1	8.8	24	1.8	20.4
12	1.2	9.6	25	1.9	21.2
13	1.2	10.6	26	1.9	22.2
14	1.3	11.4	27	1.9	23.2
15	1.4	12.2	28	2.0	24.0
16	1.4	13.2	29	2.0	25.0
17	1.5	14.0	30	2.0	26.0
18	1.5	15.0			

If the straight rotary process is employed, manufacturers generally find that there is, on the average, about 20 per cent of waste, not counting the core and the sapwood. Figuring the core at 6 inches in diameter for an average log of 18 inches in diameter, because rotary logs generally run small, and figuring 2 inches as the thickness of the sapwood, the entire log contains 359 square feet of veneer to the linear foot of log, inside the sapwood, less 66 square feet in the core, which is generally considered waste, thus leaving 293 square feet to the linear foot. If 20 per cent waste in slicing is deducted, a net yield is left of 235 square feet of veneer to the linear foot. As the original log scaled 12 feet to the linear foot, this makes a yield of about 19½ square feet of veneer to the board foot of log, log scale.

In the stay-log rotary process, a half log from a log 24 inches in diameter, which is representative for this type of veneering, will yield to the linear foot, if it is perfectly clear, about 273 square feet of one twenty-eighth-inch heartwood veneer cut from the sapwood side, and about 282 square feet cut from the heartwood side, allowing for a 3-inch "dog board" and the waste in cutting down to get a sufficiently wide sheet of heartwood veneer. Figure 7 shows the cross-sectional area from which merchantable veneer is generally cut by the two processes. Manufacturers calculate that there is a 10 per cent waste in the portion from which merchantable veneer is cut. If this 10 per cent is deducted, a balance is left of 246 and 254 square feet, respectively, in cutting from the sapwood and heartwood sides.

As there are 12½ board feet, log scale, for each foot in length in the half log referred to above, this makes a yield of approximately 20 square feet of veneer for each board foot, log scale. This figure corresponds with the general average of 20 obtained from reports of veneer manufacturers.

Because there is a somewhat greater waste in cutting from the sapwood side on account of the "dog board" being all heartwood,

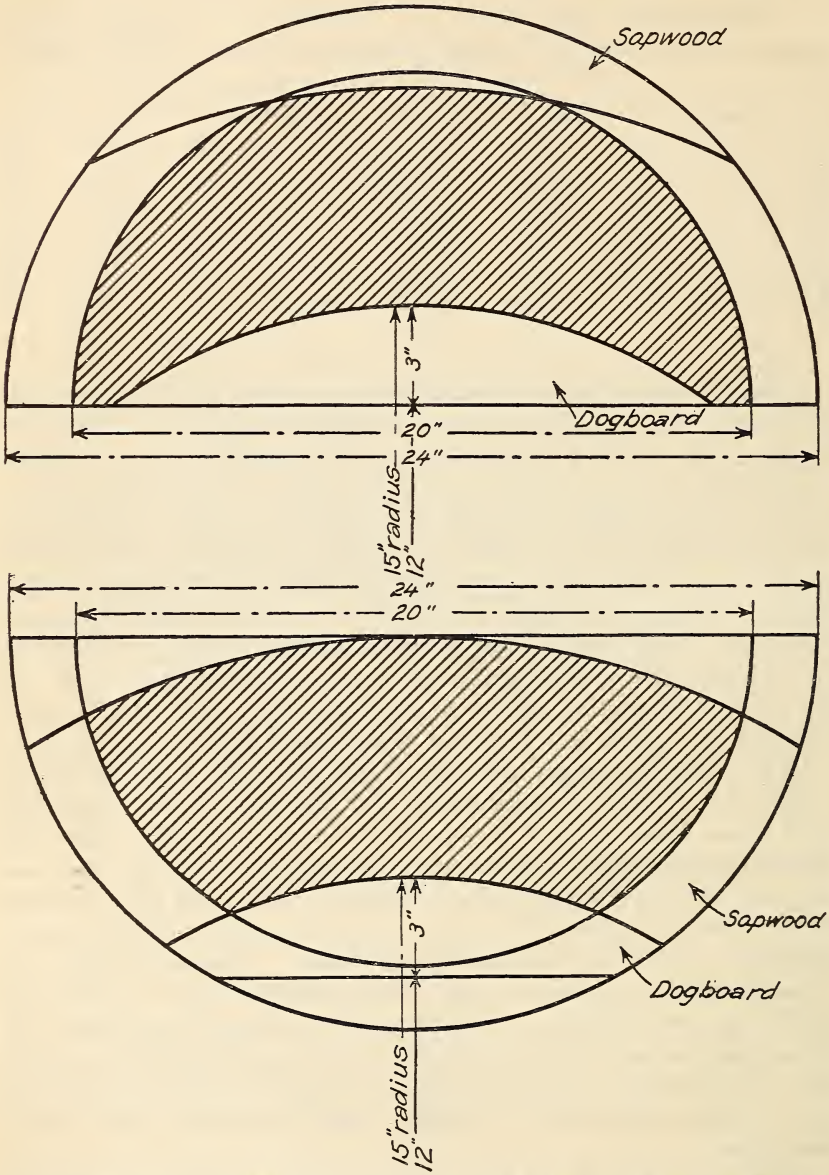


FIG. 7.—Diagrammatic cross sections of two walnut half logs showing how the veneer is sliced by the stay-log rotary process from the sapwood side (above) and heartwood side (below). In both sketches the portion above the upper curved line is trimmed off before a sheet of merchantable size is obtained. That below the lower curved line is the dog board. The part below the dog board in the lower sketch is trimmed off to secure a face for attaching the log to the veneer machine.

the yield from clear flitches will be on the average somewhat less than it is when the cutting is from the heartwood side. If the heart-

wood is defective the yield might be made greater by cutting from the sapwood side.

In the straight-slice process the principal waste is in squaring the log lengths and in the "dog board." A 20-inch log may be taken to illustrate the straight-slice method. Squaring this to 14 inches will remove nearly all of a 2-inch rim of "sap" and cut down to a heartwood face of about 8 inches in width. If allowance is made for a 10 per cent waste, as in stay-log rotary, a possible yield is given of 353 square feet of veneer to the linear foot of log, after a 2-inch "dog board" is deducted. As there are 16 board feet, log scale, to the linear foot in a 20-inch log, each log-scale foot will yield about 22 square feet of veneer. The figure generally given by firms that make straight-sliced veneer almost exclusively is 20 square feet to the board foot, log scale. The small amount of sapwood that was not removed in squaring the timber probably accounts for the difference in these figures.

If it is cut in halves for slicing, the log is not squared. The sapwood is largely trimmed off, and the back, or outside, of the log is trimmed down to a flat surface in order that the half log may be held in the veneer slicer. As there is a little less heartwood trimmed off by this method, the yield in veneer will be slightly greater. Although there are two "dog boards" to a log if the half log is used, each one is thinner than the "dog board" from the entire log.

The yield to the board foot of log does not, therefore, differ greatly in the three different processes—straight rotary, stay-log rotary, and straight slice—the general average of 20 square feet of veneer to each board foot of log applying very closely in each case.

If dimension walnut veneer is made from small clear pieces, only about 15 square feet of veneer is obtained to one board foot, log scale, of the logs from which the clear pieces were cut. As a matter of fact, a clear block 1 foot by 6 feet by 6 inches, containing 36 board feet, which is equivalent to about 30 board feet, log scale, will yield about 880 square feet of veneer, or 29 square feet to each board foot, log scale, in addition to a three-fourths-inch "dog board." Therefore only about one board foot of the clear piece is required to produce the same amount of veneer as may be obtained from 2 board feet calculated on the basis of the entire log; that is, only about one-half of the log is used for the small clear blocks. The remainder of the log not used in producing the clear pieces may be utilized for lumber and dimension material. Furthermore, logs of lower grade may be used than are required in making the larger-sized veneers.

Dimension veneer, cut to the size required by factories, is often obtained from veneer made by the rotary process. This plan involves much trimming of the veneer, but it makes unnecessary the

shipping of a great deal of stock which would not be adapted to the needs of the purchaser.

Of sawed veneer the yield is about half what it would be in straight sliced, because the saw kerf is about the thickness of the veneer sheet. Thus, a 20-inch log with an equivalent volume to the linear foot of 524 square feet of veneer one-twentieth inch thick, after it is squared, and 10 per cent is deducted for waste in the sheets and in the "dog board," yields 126 square feet of veneer to the linear foot. This makes only about 8 square feet of veneer to the board foot of log.

Kinds of veneer.—Walnut veneer is generally termed plain, striped, or figured, although there are no hard and fast lines of distinction separating the three kinds.

Plain veneer is without stripe or figure. It is produced mainly by the rotary method, but some of it is made by straight slicing from the log in the tangential direction. (Pl. VI, fig. 1.) The veneer produced by the straight rotary process is generally plain. In forest-growth timber in which the annual rings are not very distinct the straight rotary method gives a coarse effect to the veneer, and in open-growth timber the more distinct growth rings give a still coarser effect, producing a very "wild" design. (Pl. VI, fig. 2.) Plain veneer is also produced by the stay-log rotary process. If cutting is from the sapwood side, the effect is somewhat similar to that produced by the rotary process, but some striped effect is obtained, especially toward the center of the log. If cutting is from the heartwood side, the striped effect is obtained at first, the veneer becoming plain in the middle, and entirely plain before the flitch is sliced down to the "dog board." Plain veneer is also produced by straight slicing near the outside of the log.

In striped veneer the lines caused by the growth rings are fairly straight. This effect is produced both by straight slicing and the rotary stay-log method. The veneer straight sliced from near the center of the log has the most distinctly striped effect, especially if the veneer is from an open-growth tree in which dark and light lines alternate. These stripes are sometimes so marked that the veneer resembles that made from Circassian walnut. In straight slicing the stripes become broader as the sheets are cut at a greater distance from the center and the striped effect is not so pronounced.

Striped veneer is produced by the stay-log method when the cutting is from the heartwood side. Near the center of the log a quartered effect is produced. (Pl. VII, fig. 1.) At a short distance from the center striped veneer is obtained along either edge of the strip. Slicing from the outside of the log gives a striped effect to the middle part of the sheets cut near the center of the log.

Figured veneer is cut from curly or highly figured wood. Walnut veneer cut on the quarter either by the straight-slice or stay-log rotary process shows a striped and cross-figured effect if the grain is wavy or curly. (Pl. VII, fig. 2.) This waviness of grain is not brought out so well if the cut is made tangentially. In figured stumps or "butt" wood the curl is along the surface of the trunk, and the cross-figured effect is here obtained by slicing along the surface. (Pls. VIII and IX.)

Highly figured veneer cut from burls, crotches, and stumps has a great variety of figure. (Pl. X, figs. 1 and 2.) Burls are particularly highly figured with islets and bird's-eye effects. Burls from very old trees often have a mottled appearance on a glossy dark groundwork, ranging from almost jet black to lighter shades of brown or chocolate color. This gives them an extravagant value. Such highly figured veneer is sometimes marketed under the names of "French burl" and "Circassian walnut."

Prices of veneer.—The prices given in Table 20 prevailed in the summer of 1919 for different kinds of walnut veneer. There is considerable range in price within some classes because the veneer itself differs greatly in quality and figure.

TABLE 20.

Sap and defective	cents per square foot	⅛ to ¾
Plain rotary	do	¾ to 1
Straight sliced, plain	do	1 to 1½
Straight sliced, cross figured	do	1½ to 2½
Highly figured (including stump wood)	do	3 to 20
Burl wood	do	3 to 30

Some manufacturers who turn out high grades of walnut veneer got an average of 2½ cents a square foot for their product. The average value, derived from reports to the census for 1904, was $14.70 a thousand square feet, or nearly 1½ cents a square foot.

GRADES AND PRICES OF VENEER LOGS.

Walnut is a timber so variable in quality that veneer makers find it difficult to draw up any hard-and-fast rules that will indicate the value of any particular log. They take the view that each log must be judged on its own peculiar merits, with reference to its size, the amount of sapwood, the straightness and form of log, the number, size, and position of defects, and, particularly, the kind and amount of figure in each log.

Veneer manufacturers do not generally publish any prices for their logs, for they claim that the prices depend on the quality of

each log and the general run of the lot. The company's log buyer usually proposes a lump sum after he has gone over the logs carefully.

Some veneer companies buy both plain and figured logs and saw the plain ones into lumber. Others buy only figured logs. Most firms will take logs that are at least fairly clear and 16 inches and over in diameter at the small end, or as small as 14 inches if there is a sufficiently large portion of clear heartwood, or if the log is figured. They prefer logs that are 18 inches and up and clear of defects. Logs having more than a 2-inch ring of sapwood are not so well adapted for making veneer unless they are very large.

Merchantable stump or "butt" wood should be at least 22 inches in diameter at the small end, and from 30 to 42 inches long, according to the specifications of different buyers. Some manufacturers use lengths of 30 and 36 inches to correspond with the standard panel sizes. Figured stumps usually bring a price of $100 to $500 a thousand board feet, depending on size and figure.

Veneer logs should have a minimum length of a little over 8 feet. Some mills buy 6-foot logs, and some accept 4½-foot logs, if they are of exceptional size and quality. During the first half of 1919 the price of walnut veneer logs ranged from $75 to $175 a thousand board feet, log scale, depending on size and quality.

Walnut burls are very high in price, and, on account of their irregular form, are usually sold by the pound. Before the war the general range in price was 10 to 15 cents. Genuine burls are now very scarce.

Two somewhat common grades for walnut veneer logs are as follows: No. 1 logs, which may have one or two sound knots if the logs are 10 feet or over in length, but must be free from worm holes, bird pecks, and shakes; and No. 2 logs, which must have a clear length of at least 43 inches.

WASTE.

The waste in the manufacture of walnut veneer is mainly in the form of the loss that results from trimming down the flitch sufficiently for a sheet of merchantable veneer to be cut; the "dog board," or core, left after cutting off as much veneer as possible; the defects trimmed out of the veneer, including pith center and sapwood; and, in the case of dimension veneer cut from rotary stock, the loss from cutting to size.

The only data available on the amount of waste in different processes are those derived from calculating the yield of average or representative logs, as given in the section on "Production." The proportions of waste in different processes, according to these cal-

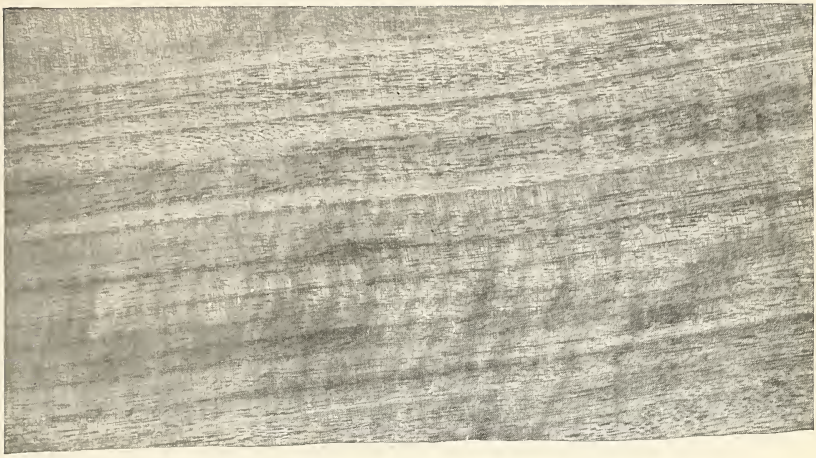


FIG. 1.—A PIECE OF STRIPED WALNUT VENEER.

Sliced on the quarter either by the straight-sliced process or by stay-log rotary cutting from the heartwood side of the half log.

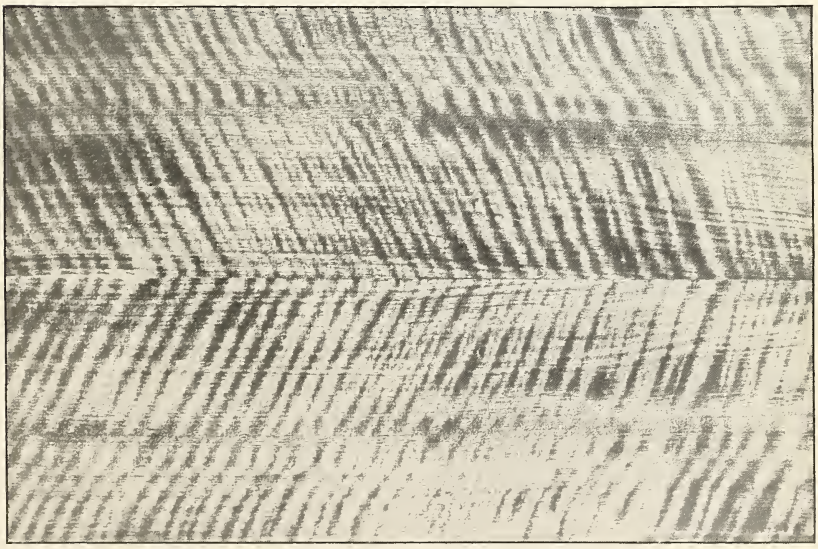


FIG. 2.—PANEL COMPOSED OF TWO MATCHED SHEETS OF CROSS-FIGURED WALNUT VENEER.

A PIECE OF FIGURED WALNUT "BUTT" WOOD VENEER.

Produced by slicing in the stay-log rotary process from the outside of the log—that is, approximately in the direction of the annual-growth rings.

SMALL SHEET OF FIGURED "BUTT" WOOD VENEER AS IT COMES FROM THE SLICER.

The light-colored wood is sapwood. The figure is in that part where the rings of growth bend out toward the root spurs.

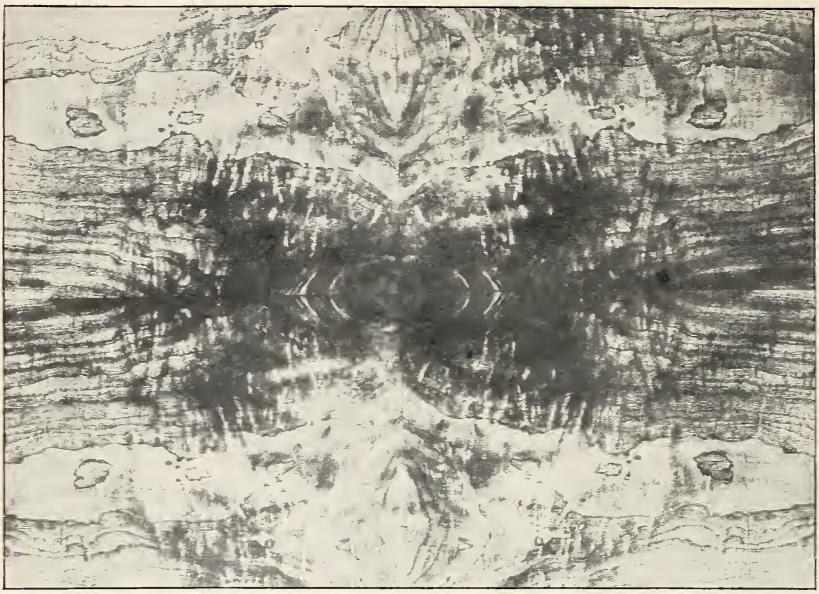


FIG. 1.—PANEL COMPOSED OF FOUR MATCHED SHEETS OF FIGURED WALNUT VENEER.

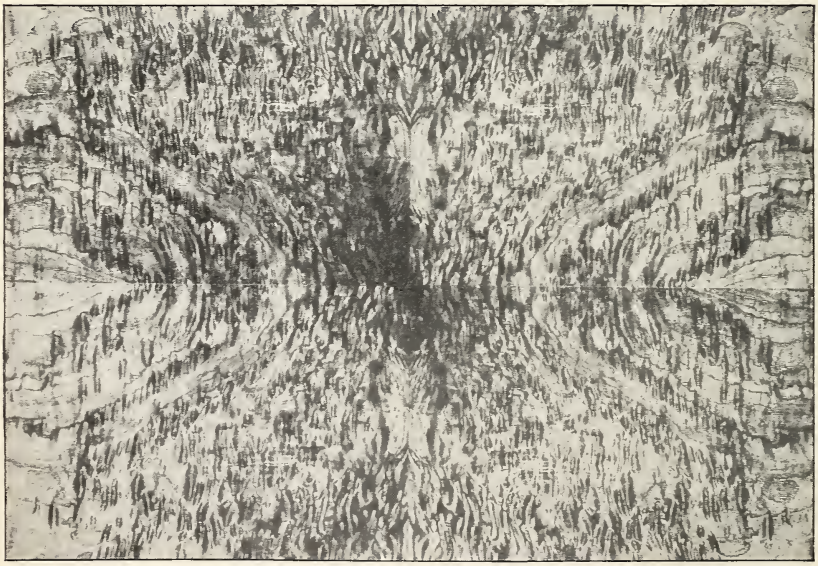


FIG. 2.—PANEL COMPOSED OF FOUR MATCHED SHEETS OF HIGHLY FIGURED "BUTT" WOOD VENEER.

culations, are given in Table 21. The amount of waste in the industry as a whole may be approximated by converting into terms of veneer the total quantity of logs used for veneer manufacture, and comparing this amount with the actual yield according to the reports of veneer manufacturers. If the average log is assumed to be 20 inches in diameter there is about 733 square feet of veneer one twenty-eighth inch thick and 16 board feet to each linear foot of log, or approximately 46 square feet of veneer to each board foot of log. If, according to figures on the production of walnut veneer for 1917, 20 square feet of veneer is produced for each board foot of log, 43½ per cent of the log is veneer stock, and 56½ per cent is waste. As about 50 per cent of the total output of walnut veneer is straight sliced, 25 per cent straight rotary, and 25 per cent stay-log rotary, a weighted average of the percentages of waste shown in Table 21 gives a general average of 54 per cent for the industry. This corresponds closely with the general average of 56½ per cent, as determined from the manufacturers' reports.

TABLE 21.—*Calculated percentages of waste in the manufacture of walnut veneer by different methods.*

Method.	Diameter of representative log.	Entire volume of log, in terms of veneer, per linear foot of log	Amount of veneer obtained per linear foot of log.	Waste.
	Inches.	*Square feet.*	*Square feet.*	*Per cent.*
Rotary proper	18	594	235	60
Rotary, stay-log	24	[1] 528	[1] 250	52
Straight-slice	20	733	353	52
Sawed	20	524	126	76

[1] Half log.

From the standpoint of utilization there are three general classes of waste in veneer manufacture: Trimmings from logs, flitches, and veneer sheets; pieces such as "dog boards" and cores that are left after cutting the veneer; and defective material, including sapwood. The first class of waste is useful only for fuel and is generally disposed of in that way. "Dog boards" from straight-sliced veneer, if they are not too defective, are often resawed into boards; if they are figured, valuable stock may be secured from them. The "dog board" of the stay-log rotary process, on account of the stay-bolt holes, is generally useful for fuel only. Cores are usually 3 or 4 inches in diameter and are often resawed into dimension stock if they are not too defective. Such dimension material shortly after the war often sold for $50 to $80 a thousand board feet at furniture factories. Veneer cores have been used for porch pillars, but they are

usually too defective for this purpose and, moreover, there is little demand for a perfectly straight and plain pillar. These cores are not generally suitable for rollers because the wood is too soft. Most manufacturers use them for fuel.

Defective and sapwood veneer is often used for fuel because of the small demand for such stock. Some manufacturers claim that often they can get only one-eighth cent a square foot for it, and that it is not profitably marketed at this price. It is used for backs of pianos, bureaus, and mirrors, and for drawer bottoms. Furniture factories prefer to buy yellow poplar or some other cheaper veneer for such purposes because the use of the larger sizes in which it is to be had involves less work and a lower cost for the labor in using it.

Some manufacturers utilize their logs very closely in making straight rotary veneer. They stop the slicing before the core is too small, and then either saw or straight slice it. In this way less of the heartwood is wasted.

USES.

Walnut veneer is used mainly in dining and bedroom furniture, musical instruments (principally pianos and phonographs), and cabinetwork in general. It is used, as a rule, in the panels only, the smaller pieces, such as corner posts, being made solid. Furniture manufacturers may either make their own panels or buy them made to size from panel manufacturers.

TIES.

Walnut makes a satisfactory tie because of its durability. It is used untreated by the railroads. Locust, black walnut, and white oak are generally considered the best tie woods and command the highest prices.

There is a considerable quantity of small and defective timber in the course of logging walnut, which may be converted into ties at a profit. Ties are usually 6 by 7, 6 by 8, 7 by 8, or 7 by 9 inches in cross section and 8 or 8½ feet in length. A 12-inch log, if it is straight and not too defective, may be cut into a 7 by 9 or 7 by 8 tie. A 10-inch log will make a 6 by 8 tie if it is not necessary to cut the log down on account of a defect. Top logs and especially the limbs of walnut are liable to be so crooked that there is much waste in cutting up such material. Ties as small as 5 by 7 inches are sawed for use on sidings and on trolley lines.

The prices paid for walnut ties generally amount to about the same as the market value of cull walnut lumber. It is usually, therefore, a question with the manufacturers whether it is profitable

to turn this kind of stock into ties. There is, however, a larger percentage of overrun in sawing into ties, and for this reason the manufacture of ties is often profitable, especially if the mill is in a region where the best prices are paid. Defective ties are sometimes cut into mine caps about 6 inches thick if there is a demand for such material. Wedges to be used with the caps are also sawed out of waste walnut.

POSTS.

Close utilization may be effected by sawing small and defective walnut into fence posts. Although it is not so durable as locust and some other woods, walnut is suitable for posts and is in demand for this purpose. A common size for posts is 5 by 5 inches at the bottom and 2 by 5 inches at the top. This manner of sawing is advantageous, because the yield is greater than it would be if the posts were of the same size throughout.

SECONDARY INDUSTRIES.

Walnut is manufactured by factories mainly into three classes of products—cabinetwork in general, interior finish, and firearms. Under cabinetwork are included furniture, fixtures, chairs, cabinets and cases for musical instruments and sewing machines, and caskets. Inside finish includes products of the planing mill, doors, and panels for stores, offices, and railway cars. Gun and rifle stocks and pistol grips are the parts made for firearms. Of minor importance are such small articles as handles of various kinds and fancy boxes.

Table 22 gives the annual consumption of walnut, as reported by factories and grouped according to classes of products. These figures apply to the years 1909 to 1913 and represent the pre-war consumption. There has probably been an increase over these figures in the use of walnut for general cabinetwork, on account of the great recent demand for walnut furniture. This increase in the use of walnut for furniture has been largely offset by the greatly lessened demand for certain kinds of cabinetwork, such as sewing-machine cabinets, which were made almost entirely for supplying the foreign trade. In other classes of products lessened foreign demand is also generally more than balanced by an increased use of similar products at home. It is believed, therefore, that the figures shown in the table are somewhat representative of the importance at the present time of the different industries in walnut utilization. The figures on the cost of material are of value only for the purpose of comparison.

TABLE 22.—*Reported annual factory consumption, and cost of black walnut, by industries.*[1]

Industry.	Quantity used annually.		Average cost per 1,000 feet.	Total cost f. o. b. factory.
	Feet board measure.	Per cent.		
General cabinetwork[2]	10,147,407	42.30	$80.66	$818,508.77
Instruments, musical	4,991,808	20.81	81.31	405,898.95
Planing-mill products, sash, doors, blinds, and general millwork	4,606,420	19.20	76.55	352,618.50
Firearms	1,700,135	7.09	61.53	104,601.00
Caskets and coffins	474,000	1.98	106.66	50,557.00
Machinery and apparatus, electrical	452,600	1.89	79.53	35,994.00
Vehicles and vehicle parts	390,450	1.63	91.44	35,702.00
Chairs and chair stock	263,200	1.10	76.73	20,196.00
Car construction	256,181	1.07	87.63	22,450.00
Boxes	163,250	.68	39.27	6,411.00
Frames and molding, picture	125,004	.52	117.76	14,721.00
Instruments, professional and scientific	71,200	.30	64.72	4,608.00
Clocks	58,527	.24	65.22	3,817.00
Bungs and faucets	56,000	.23	31.04	1,738.00
Sporting and athletic goods	41,000	.17	92.93	3,810.00
Woodenware, novelties, and dairymen's, poulterers', and apiarists' supplies	38,547	.16	96.29	3,711.50
Handles	29,050	.12	45.65	1,326.00
Brushes	26,700	.11	77.15	3,060.00
Patterns and flasks	21,500	.09	57.44	1,235.00
Laundry appliances	20,000	.08	90.00	1,800.00
Whips, canes, and umbrella sticks	20,000	.08	51.00	1,020.00
Machine construction	10,817	.05	40.40	437.00
Plumbers' woodwork	10,300	.04	78.64	810.00
Agricultural implements	8,000	.03	16.50	132.00
Ship and boat building	3,750	.02	120.80	453.00
Rollers, shade and map	2,000	.01	110.00	220.00
Carpet sweepers	500	(3)	200.00	100.00
Total	23,988,346	100.00	78.99	1,894,935.72

[1] Data collected by the Forest Service during the period from 1909 to 1913, inclusive.
[2] Includes furniture, fixtures, and cabinets for sewing machines.
[3] Less than one one-hundredth of 1 per cent.

Table 23 gives the same data by States. Ohio, Indiana, Illinois, and Kentucky are the States that have comparatively large amounts of walnut available and that use large amounts in manufacturing finished products. The States of New York and Michigan, which have to go farther for their raw material, also use considerable quantities in manufacturing.

TABLE 23.—*Reported annual consumption of black walnut in factories, by States.*[1]

State.	Quantity used annually, feet board measure.	State.	Quantity used annually, feet board measure.
Indiana	5,538,115	West Virginia	49,500
Illinois	4,340,350	Rhode Island	40,300
Ohio	2,920,040	Kansas	26,500
New York	2,629,128	District of Columbia	26,000
Michigan	1,473,128	Iowa	11,500
Kentucky	1,463,500	South Dakota	10,500
Massachusetts	874,250	South Carolina	10,000
Pennsylvania	782,615	New Hampshire	9,000
Connecticut	648,650	Georgia	7,000
North Carolina	594,000	Mississippi	3,000
Maryland	548,500	Maine	2,000
Tennessee	520,000	Oklahoma	2,000
New Jersey	301,850	Delaware	1,948
Virginia	277,300	Oregon	1,900
Minnesota	161,639	Nebraska	1,252
Vermont	141,042	Washington	1,000
Missouri	140,573	Louisiana	500
Texas	135,000	Montana	250
California	112,916	Colorado	100
Alabama	62,500		
Wisconsin	62,000	Total	23,988,346
Arkansas	55,000		

[1] Data collected by the Forest Service during the period from 1909 to 1913, inclusive.

FURNITURE.

The extensive use of walnut for furniture dates back to the latter part of the seventeenth century, when walnut furniture replaced oak in Europe. England was the first to appreciate the value of American walnut, and it was used there at that time and often preferred to the English or Circassian walnut of Europe. Elaborately carved pieces, often with highly figured veneer, were well liked. Exports to England reached fair proportions by the end of this period, and large shipments for that purpose have gone to European countries ever since. Walnut furniture (including chairs and chests of drawers) was made in New England in the latter part of the seventeenth century, and at about the same time it was used in Virginia. In the eighteenth century wild cherry and walnut were the principal native cabinet woods. During the first half of the eighteenth century much furniture was made of walnut in eastern Pennsylvania and New Jersey; probably the best was made in and near Philadelphia. The walnut grown in this region had a uniformly dark and rich color which was well liked. Mahogany also was much used. The "lowboy," a very low dresser with one or two drawers, and the "highboy," a dresser of six or seven drawers, were characteristic pieces of furniture at that time.

In the latter part of the eighteenth century walnut as a furniture wood went out of fashion in England. During the first half of the nineteenth century, however, walnut was utilized in large quantities for furniture in this country. The source of supply of the timber was now farther west than the region of supply during the eighteenth century, and large amounts were obtained from Ohio and Indiana for shipment to eastern factories, mainly in Philadelphia, New York, and Boston, where furniture of the better quality was produced. Veneer was much used at that time. During the third quarter of the nineteenth century heavy, cumbersome walnut furniture of grotesque and ungainly patterns came into vogue in this country. The dark stain with which the wood was generally covered gave it a uniformly dull, lifeless appearance, which, together with the unattractiveness of these styles, resulted in so discrediting the wood that by the latter part of the nineteenth century it became extremely unpopular. Its employment in large quantities during the earlier part of the nineteenth century served to reduce greatly the best of the available supply in eastern United States, and that fact in time helped to discourage its use.

During the past several years there has been a revival in the demand for walnut furniture in this country. This is mainly because of the adoption of lighter finishes and figured effects, which are in contrast with the dark, somber finishes in earlier use, and because of

the obtaining of new supplies of the wood. On account of the high price of oak and the relative scarcity of mahogany that resulted from restricted imports during the war, walnut has recently displaced these woods to a large extent for furniture.

There are several reasons for the high value placed upon walnut as a cabinet wood. It has good seasoning properties, will hold its shape well, and will not deteriorate after it is properly seasoned; it has an attractive appearance, may be polished to a smooth surface, and will take stains and varnishes very well; it may be cut easily with tools, and is thus adapted to carving and veneer making; it may be glued with very satisfactory results; it possesses moderate strength and weight.

To a degree equaled by few other woods walnut possesses all the different qualities that are essential to a first-class cabinet wood. Greater strength would be of advantage, but this would involve greater weight and greater hardness, and the greater hardness would interfere with its being easily worked with tools.

The principal articles of furniture made of walnut are dining-room and bedroom suites. Dining-room tables of walnut are much in demand, because they are very serviceable and do not show to the extent to which some other woods do the hard usage to which such tables are subjected. Bookcases, desks, living-room tables, and many other pieces are commonly made of walnut. Recently, on account of its serviceability, there has been a considerable demand for office furniture of walnut.

There are three general classes of furniture—that made along plain lines and of figured wood; that characterized by elaborate design and made almost altogether of plain wood; and cheaper grades of furniture, simple in form and of plain wood.

The greatest demand now is for walnut furniture of plain lines and finished to show the natural figure of the wood. Much plain walnut furniture is made, but usually some figured wood is employed for the most conspicuous parts. Large-figured effects in walnut are not so popular now as formerly. The highest class of walnut furniture generally has stripe and cross figure, and often some crotch and burl-wood pieces. Some large, heavy walnut furniture of antique design, usually with large carvings, is also made. These pieces are for large rooms of expensively furnished houses, and are generally copied after the early-period designs of walnut furniture.

Dining-room tables of walnut are manufactured in large numbers. They are generally finished in plain wood, because the only conspicuous part is the top, and this is often kept covered. Table tops are generally made of three or five plies, with a core of solid wood and one or two sheets of veneer on either side of the core. Occasionally table tops are made with the upper ply of sawed veneer one-sixteenth

or one-eighth inch thick. This will stand more wear than the thinner sliced veneer if hard usage is involved. The top may also have a small bent rim of walnut along the edge to cover the core. Table rims are usually made of three or four plies, each about one-fourth inch thick. These may be of walnut or covered over with walnut veneer.

Buffet and serving-table tops are made of three or five plies. They may be plain, but more often they have stripe and cross figure. Doors and drawer fronts of buffets and serving tables are also made of three or five plies and they generally show some figure. Small drawer fronts are often of highly figured crotch or burl. The ends of such pieces are generally of plain wood, except in very expensive stock. Doors in furniture of high grade have a ply of walnut veneer on the back and an edge of walnut.

Plain rotary-cut walnut veneer is used also for drawer sides and bottoms. China closets are usually made of plain wood. The shelves are more often made of some cheaper wood with the front edge of walnut veneer.

In bedroom furniture the same general style of finish is used. Built-up tops may be plain, but more often they have some figure. Drawer fronts and panels are made of three or five plies, and, if they are conspicuously placed, figured effects are often made use of, including stump wood and burl.

Legs, corner posts, and mirror frames are to a very large extent made of solid pieces of other woods, except in the manufacture of the most highly priced furniture. In very expensive pieces such parts as the corner posts are veneered in order to secure the desired figure. In low-priced walnut furniture the ends and other inconspicuous parts are entirely of less expensive woods.

The best panels in common use are made of five plies. The core is of some such wood as oak, quarter-sawed red gum, birch, chestnut, basswood, or yellow poplar. This should be constructed of narrow pieces to prevent warping, and the two plies on either side should be so laid that the grain in the ply next to the core is at right angles to that of the outside ply and that of the core. This method makes a strong panel and minimizes the effects of shrinking and swelling. A small piece of highly figured veneer, usually stump wood, crotch, or burl, is often placed upon the center of a large panel of plain or striped wood. This is called an "overlay" and is popular at the present time. An "overlay" of walnut burl or crotch is sometimes used on mahogany furniture. It is stained to match the mahogany panel and is regarded as adding much to the attractive appearance of the mahogany. Maple burl is sometimes used as an "overlay" panel with walnut.

Carvings often add greatly to the attractive appearance of the article. The finer, more detailed carvings are usually made separately and afterwards attached to the wood. On account of the high cost of labor wood carving is expensive, and many imitation wood carvings are made. A tendency is now observable, however, toward the use of simple carvings made of genuine wood. These carvings are sometimes made by machinery and at a lower cost than when made by hand.

Walnut finishes are now more nearly like the natural color of the wood and vary from light to dark brown. A medium light-brown tone that shows a figure of darker streaks is considered especially attractive. Very light and very dark brown finishes are not so pleasing. Walnut shows to better advantage when rubbed to a dull finish than when given a high polish. These dull finishes are popular at the present time.

Probably the largest amount of walnut used for furniture is in the form of veneer, for in a very large part of this furniture the solid (not veneered) parts are of some other wood. All kinds of walnut veneer are used in furniture, the highest grade largely demanding figure, stripe, cross figure (often with rippled and "fiddleback" effects), figured stump wood, crotch, and burl. A large amount of plain veneer is used. Rotary veneer that is unsuited for outside work is sometimes used for sides and bottoms of drawers and in other places where it is not conspicuous.

Many factories buy much of their walnut cut to the approximate dimensions of the finished pieces. This applies particularly to dimension squares. Common sizes purchased are 2 by 2, 2½ by 2½, and 3 by 3, 18 to 36 inches long, and used largely for corner posts and legs. Some manufacturers consider that the purchase of this stock at, say, $75 a thousand board feet, means a saving to them in both labor and machinery in comparison with the cost of working it up from lumber. Other manufacturers find that, if they have to dry the stock, and if it is not then perfectly clear and first class in every way, no saving is effected, on account of the waste involved. One of the greatest objections to the purchase of dimension stock for furniture is that there are so many different and special sizes used, it is often not practicable to have them cut at the sawmill. Moreover, styles of furniture change frequently and with resultant changes in the sizes of the different pieces.

Furniture manufacturers are, therefore, purchasing more walnut lumber and cutting it to the desired sizes. No. 1 common is the grade generally found most advantageous. Some factories purchase the firsts and seconds grade also, and others get No. 2 common and better and make all their stock from this combination of grades. The most common thicknesses used are 4/4, 5/4, 6/4, and 8/4.

Furniture factories generally buy steamed walnut lumber in order that the sapwood as well as the heartwood may be used. Some factories make a practice in manufacture of so placing squares and other solid walnut pieces that only the heartwood is exposed to the outside.

The principal waste in furniture manufacture is in the making of panels from the veneer sheets. Panel manufacturers estimate that there is about 50 per cent waste in rotary and stay-log veneer, and 60 per cent in straight sliced. If the veneer sheets are cut at the veneer mill to the approximate size of the panel, or sliced from small clear blocks to the required size, the waste in veneer is much less. In the latter case, it is figured that the waste in veneer ranges between 10 and 20 per cent, with an average of 15 per cent.

There should be less waste in solid stock if the dimension sizes are purchased than if they are cut from lumber. Waste in dimension material may come from stock that is poor because of a lack of proper or sufficient seasoning or because of improper handling. Scant sizes, as well as knots and other defects, are also the cause of waste in this material; or, loss may result from a change in the size required, after the stock has been purchased. The waste of high-grade dimension stock is, of course, a much more serious matter to the factory than the waste of a like amount of No. 1 common lumber from which it is generally sawed by the furniture makers. The use of lumber instead of dimension stock requires, of course, the shipment of defective material which would have been cut out at the mill; but this is preferable to the waste of dimension stock. The purchase of standard sizes of clear dimension material should be profitable to the furniture manufacturer. The amount of waste in the use of a certain grade of lumber depends on how advantageously the required sizes may be cut out. The greater the number of sizes to be cut, the less the amount of waste should be.

The most common substitute for walnut in furniture manufacture is red gum. It is a general practice to utilize red-gum wood finished in imitation of walnut for corner posts, legs, mirror frames, and, in fact, for practically all but the veneered parts. The reason for this has been that gum was a lower-priced wood than walnut. On account of the recent rapid rise in the price of red gum, however, there is now relatively less difference in cost. The same styles of furniture are generally made in either walnut or mahogany, and the gum may be finished in imitation of either wood. This is obviously a distinct advantage to the furniture manufacturer. Birch also is used in the same way. On account of the difference in the figure or grain, neither of these woods has the same appearance as the walnut, even when it is stained to match the color. Consequently, in making the highest class of walnut furniture, walnut wood is utilized for all outside

work. Some factories finish their best pieces with walnut on the edges and backs of doors and on the inside of drawers.

The quarter-sawed plain heartwood of red gum is considered most desirable as a substitute for walnut, because it is not so liable to warp as the plain sawed, and the heartwood is nearer the natural color of walnut. The sapwood is objectionable because of the lighter color, and the figured wood is not so suitable because it does not match so well the appearance of the walnut. Wood with dark streaks is objectionable for this reason.

As a matter of fact, walnut is a suitable wood for the solid pieces in furniture, and there is no advantage other than that of lower cost to be gained by the use of another wood, and the substitution is liable to make the piece less attractive.

Black walnut is sometimes used in the form of veneer to imitate Circassian walnut. Only pieces with unusually dark, distinct streaks running through them are suitable, such wood being sometimes found in the extreme southwestern portion of its range. Some very pleasing effects are obtained from this kind of wood, but the usual plain or figured walnut is unsuitable.

Plastic material colored to resemble walnut is quite often used to imitate the carved walnut wood. These imitation carvings are pressed to shape in a mold that is usually made from the genuine wood carving and so successfully simulates the pores of the wood that a resemblance to walnut wood is produced. Such imitation carvings, on account of their uniform coloring, are apt to have a dull, lifeless appearance and do not match well the genuine wood. These composition carvings are often overdone in detail and are generally distinguishable from the wood carvings, which are considered more attractive and in better taste.

MUSICAL INSTRUMENTS.

Walnut is well suited for the manufacture of cases for musical instruments because of those characteristics that make it so valuable as a cabinet wood, namely, its good seasoning and working qualities, its adaptability to panelwork, and its fine appearance when finished.

In this industry its greatest use at the present time is for phonograph cabinets. The solid pieces used for legs, corner posts, and cross-pieces are of plain walnut; panels are usually of figured veneer, the striped wood being popular. The cabinets are usually finished in a light shade, but they may also be given a dull, dark wax finish in antique style to match old walnut furniture. Lumber about 1¼ inches thick of the Nos. 1 and 2 common grades is used to a large extent for these cabinets. The lumber manufacturer sometimes finds it advantageous to make these cabinets in conjunction with the saw-

mill. In this way a very close utilization is effected, and much small-sized and low-grade lumber may be made use of. Mahogany and walnut are sometimes used interchangeably in the manufacture of these cabinets, a light stain being used to give a walnut finish and a dark stain to give a mahogany finish. By this method one wood may be used for the solid parts and the other for the panels, walnut being generally used for the former and mahogany veneer for the latter. A cabinet made in that way does not give so good an appearance as if all walnut or all mahogany had been used. Moreover, each wood should be given a finish particularly suited to it.

Piano cases are sometimes finished in walnut. There was formerly a good demand in Europe for walnut-finished pianos, but this business was interrupted by the late war. There has recently been a large demand from Australia, Mexico, and South America for pianos finished in walnut. Exports to these countries were, in fact, increased by the war, because the supply of German-made pianos was cut off. The United States is the largest manufacturer of pianos; before the war Germany was second, and England third. Figured walnut is now largely used for walnut piano cases. The figured "butt" or stump wood is quite generally used to form a panel for the front. The figured ends are matched together in the middle, and the figured wood generally runs out into plain wood on either side. Walnut cases are sometimes given a very light finish, resembling maple. The different streaks and shadings in the figured walnut are regarded as giving more character to the wood than the figured maple does. Walnut is sometimes used for the core wood on which the veneer is placed, because under varying moisture conditions it shrinks, swells, and warps very little.

Piano benches are made of walnut to match the finish of the piano. The seat is usually a panel of figured veneer which is veneered with walnut on the edges also, in order to give the appearance of solid walnut.

Walnut was formerly much used in the manufacture of reed organs, but very few of these instruments are now made. The proper finish of a pipe organ depends entirely upon the finish of the woodwork of the room in which it is to be placed, and the two should be in harmony.

PLANING-MILL PRODUCTS, SASH, DOORS, BLINDS, AND GENERAL MILLWORK.

Black walnut is manufactured into many products that go to make up the finish of houses, offices, and stores. A large proportion consists of planing-mill products, such as flooring, ceiling, molding, baseboards, and those other dressed and matched materials that are considered finished when they leave the planer. Walnut was formerly much used for borders and designs in floors laid mainly in other

woods. Mahogany and cherry are now preferred, on account of their more striking reddish color, for these make a more pleasing contrast with the light-colored woods, oak and maple. Walnut is also much used in the form of panels for inside finish, especially in cafés and public buildings where fancy figured effects are in demand. Door stiles and rail stock are sometimes made of plain sawed veneer one-sixteenth to one-eighth inch thick. This thickness of veneer insures greater wear than can be obtained from the thinner sliced veneer. The door panels are of figured sliced stock. Walnut is well adapted for these uses, because it polishes to a smooth, even surface, takes stains and other wood finishes well, and has a wide range of possible effects in the finished state. Much of this class of material was exported in former years because of the popularity of walnut finish in foreign countries. The demand in this country has been much greater in recent years than formerly.

SEWING MACHINES.

Walnut has been used in very large amounts for sewing-machine cabinets on account of its good qualities as a cabinet wood and because of its fine appearance, which is very well liked abroad. Veneer is made use of very largely. The cabinet type of sewing machine, in which the working parts may be entirely inclosed, is most commonly finished in walnut. Relatively small amounts have been used recently for this purpose, because exportations have been largely cut off, and the demand for walnut-finished cabinets in this country is very small.

FIREARMS.

Black walnut is particularly suitable for the manufacture of gunstocks. The properties fitting it for this use are as follows: It is liable only in a slight degree to warp and check, and shows only a small amount of shrinking and swelling after it has been properly seasoned; it is easy to work with tools to its final shape; it will hold metal parts with little wear; it possesses a uniformity and slight coarseness of texture which render it easily gripped and held by the hand; it has a good degree of strength without excessive weight; it will stand considerable shock without injury; on account of its dark color it is attractive in appearance and is not easily soiled.

It is important that a wood used for gunstocks should "machine" well to insure the metal parts fitting satisfactorily. Warping is particularly objectionable in the stock of rifles (for example, those used in the Army) in which the barrel is incased in wood for practically its entire length, because the warping of the wood is liable to spring the barrel out of a straight line, and thus interfere with the accurate shooting of the rifle. Cross grain is, therefore, objection-

able, for it is said that the heating of the rifle barrel will cause sufficient warping to make the gun shoot inaccurately. Figured walnut is highly prized in the butts of sporting rifles on account of its attractive appearance. Such stocks must be finished by hand, however, because the machine tool will follow the grain of the wood, inaccurate cutting of the stock will result, and the metal parts will not fit accurately. Army-rifle stocks are manufactured by very specialized machinery. The rifle blank (Pl. XI, fig. 1) is subjected to between 40 and 50 different machine operations; it is then dipped in stain; the excess stain is rubbed off; and the metal parts are fitted to it. Sapwood is used with the heartwood without discrimination. American walnut was the standard gunstock wood in the United States during the late European war, and was also used extensively by England and other European countries.

In 1861 the subject of stocks for guns was formally discussed at a convention of gunsmiths at Atlanta, Ga. The consensus of opinion among those present was that black walnut was superior to all other woods for muskets; after walnut, maple was to be preferred, and persimmon was ranked third. It was then claimed that no artificial seasoning would suffice, and that gunstock material should be air-dried for 20 years. Walnut for gunstocks was, therefore, procured both in the North and South by taking floors, beams, and joists out of old barns and mills in which some of the walnut had been seasoning for a quarter or half of a century, and also by purchasing miles of fence rails. Modern methods of kiln drying the wood have largely taken the place of air seasoning, and with much more satisfactory results. Black-walnut stocks are now dried from the green state in special kilns in about 60 days. The modern rifle and shotgun require much less wood for the stock than was used by the old-style long musket, which was incased in wood nearly its entire length. Gunstock blanks for the United States Army rifle are clear cuttings, approximately 4 feet in length, made from 2½-inch flitches, sawed from the log, and equivalent to a little better than the No. 2 common grade.

Although black walnut is the best wood for this use, yellow birch has been found to be an excellent substitute. Yellow birch is about equal to black walnut in weight, strength, and toughness, but is not quite so good in holding its shape, shrinks more, and is more apt to be cross-grained. It is light in color, but may be readily stained. Gunstock manufacturers report that birch, when properly seasoned, makes as good a stock as black walnut. Birch is more difficult to "machine," however; the production is slower; and there is more waste in the "machining" operation than with walnut. Birch timber is quite often wavy and cross-grained, and that kind of stock

is unsuited for the manufacture of gunstocks by machine process. There is also some waste in "machining" walnut stocks, but this is, for the most part, because of internal defects that are not visible on the surface of the blank. Red gum is a suitable wood for small rifles, but not for long army rifles, on account of its tendency to warp and twist.

A considerable amount of walnut is used in the manufacture of air rifles, chiefly in Michigan. Manufacturers of air rifles do not require such thick material as is used for the military rifle. The wooden stock of the air rifle usually consists of a comparatively small piece forming only the butt. (Pl. XI, fig. 2.) Air-rifle factories can, therefore, utilize fairly low-grade material by cutting out the defects. They generally use No. 1 and No. 2 common grades, 1 inch in thickness. A special grade of "shorts" is sometimes made use of. This grade consists of pieces of good quality, the length of which is less than is allowable in the upper grades. Air-rifle manufacturers can utilize this stock very closely on account of the small sizes used. Several different models are usually made, and the maximum size of the stock is about 3 to 4 inches in width by 14 inches in length in the rough. The dark-colored heartwood of black walnut is well liked for the small rifle, and the makers must either use heartwood entirely or stain the sapwood to match. Black walnut also holds screws well and is, therefore, particularly desirable for the small gun, in which the stock is a very short piece and is attached to the metal part by a few screws. Other woods also, particularly red gum, are used for air rifles and small-cartridge rifles, and are stained to resemble walnut. There is some objection to the gum on account of its warping and because there is a tendency for the screws to become loose in it. The cartridge rifle is made from lumber 1½ to 2 inches in thickness. A considerable quantity of walnut is used for shotgun butts also (Pl. XI, fig. 3), for which short pieces and such waste material as veneer cores may be utilized. Much high-grade walnut is used for pistol grips, although the individual revolver requires only a small piece. European walnut (Circassian walnut, which was long ago naturalized in Europe) has been used for gunstock material in European countries for many years. This is a satisfactory wood, but the lack of a sufficient supply has necessitated a large use of the American walnut in recent years.

FIXTURES.

Black walnut is utilized for bank, office, and store fixtures, in which it shows to good advantage in broad panels on account of its attractive color and figure. It is usually employed only for the exterior parts of fixtures and other cabinetwork. It is much used for showcases, for large cabinets in drug stores, for standing desks in

banks, for counters, and for bars. On account of its dark color, black walnut is popular for the interior woodwork of churches and lodge rooms, and for altars, pews, and Bible stands.

CASKETS AND COFFINS.

Less than 2 per cent of the total amount of black walnut used annually was reported as being employed in the casket and coffin industry. Its value for this use consists in its rich and somber appearance, and in its relative freedom from decay and the effects of moisture. It is utilized principally for high-priced caskets, the natural wood being highly polished and attractively finished, and the most expensive cases being richly carved. Oak and mahogany are much more used, however, than walnut. By far the greater number of caskets and coffins are made of some cheap wood like low-grade chestnut and covered with cloth. Coffins are not so much employed as they were formerly. Black walnut for many years was the principal coffin wood and is still used for the better grades. Black-walnut coffins are often made by hand by cabinetmakers who supply the local trade in small towns where the wood is available. The use of black walnut at the present time for caskets and coffins is largely a matter of custom or sentiment. It is restricted for the most part to regions where there is a good supply of high-grade walnut and is dependent on a personal preference for the wood.

In 1912 Pennsylvania reported the use for burial cases of over 200,000 board feet of walnut annually, and Kentucky reported one-half this amount. Other States reported small quantities. A high grade of black walnut was used for manufacture into these products.

ELECTRICAL MACHINERY AND APPARATUS.

Black walnut constitutes a large proportion of the wooden parts of telephone outfits and of other electrical apparatus. It is much used for base blocks for electrical appliances and for boxes to hold such equipment. Its dark color and excellent working qualities adapt it for these uses. It is used also to a small extent for subscribers' telephone sets, mostly of the wall kind, where it is wanted to match the woodwork of the room. The piece that goes against the wall and the bell box are the wooden parts. Black walnut is not essential for this use, however, for other woods could be substituted with the same effect. American walnut is in demand for public telephone booths in Europe, particularly where the inside of the room is finished in walnut.

VEHICLES AND VEHICLE PARTS.

The use of walnut in this industry is confined almost entirely to automobiles. It is employed for the rims of steering wheels, for which

purpose it is admirably suited. The wood has a slightly coarse texture and can be gripped well by the hand; moreover, it does not become either rough or slippery from wear. The dark color of the heartwood also precludes its presenting a soiled appearance. As they are made in sections, which are dovetailed and glued together, very strong, serviceable rims are produced. The dash or instrument board of certain makes of automobiles is covered with figured walnut veneer, which gives a pleasing appearance. For this use, waterproof glue is required, because this part of the car is frequently exposed to the weather. In general, a high grade of walnut is used for these purposes.

Battery boxes also are made of walnut. These boxes must be strong, tight, and serviceable. They are dovetailed and glued at the joints, and wooden dowels are also used to prevent their coming apart. The sides and bottoms are one-half to nine-sixteenths inch in thickness. Walnut makes a strong tight box, is not liable to warp, and is not soiled so readily as most other woods. The walnut used in the manufacture of these boxes is mostly No. 2 common and cull, five-eighths inch thick.

CHAIRS AND CHAIR STOCK.

Black walnut is used for chairs of all kinds, except very cheap ones, but it appears to best advantage in the large and ornamental kinds seen in club and lodge rooms, offices, hotel lobbies, and public waiting rooms. Its dignified and pleasing appearance makes it appropriate for such locations. It is also used to match high-grade walnut furniture, particularly dining-room chairs. It is used almost entirely in the form of lumber and dimension stock for this purpose. A small overlay of highly figured walnut veneer or burl is sometimes used to match the other pieces. Veneer is also employed to some extent for large and very expensive chairs in order to get some special figured effect.

CAR CONSTRUCTION.

About 1 per cent of the total amount of black walnut reported for factory use was utilized in the construction of railway and street cars. Practically all of it was used for the interior finish of Pullman cars, and mainly for the large panels. For such uses highly figured veneer is well adapted and largely employed on account of the beautiful effects that may be secured and because of its excellent finishing qualities. The most expensive veneers, particularly those from crotch and stump wood, are used in private cars. On the average a high grade of walnut is used in car construction.

BOXES.

The use of black walnut in the box industry is confined to making small fancy boxes for holding jewelry, silverware, and other expensive merchandise, and the box is usually sold with the article it contains. Walnut is also made into small boxes for office use. A comparatively low grade of walnut is used for making boxes; the average value of the walnut is high, however, when compared with that of all wood used in the box industry.

PICTURE FRAMES AND MOLDING.

Black walnut is an excellent wood for picture frames and molding on account of its fine appearance and its good finishing qualities, and because it holds it shape when seasoned. A very high grade of wood is required for these uses.

OTHER FACTORY USES.

Sixteen other industries reported an aggregate annual use of less than 100,000 board feet of black walnut. Some of the most important of these uses are for parts of professional and scientific instruments; for the outside finishing pieces of clocks; for bungs and faucets on account of the uniform texture of the wood, which makes them fit well; for the decorative parts of sporting and athletic goods, especially of billiard cues; for woodenware and novelties, particularly carved articles of various kinds; for fancy handles; and for brush backs. It is sometimes made into tobacco pipes to take the place of the French briar because it does not burn readily and has a very attractive grain.

There is a large range in prices reported for the smallest amounts, as shown in Table 22. The unusually high prices reported for some of these items indicate that some special stock was purchased. For instance, the 500 board feet purchased for carpet sweepers, for which a very high price for that time was paid, was doubtless figured stock. Very little walnut is now used for carpet sweepers. The 8,000 board feet used for agricultural implements at a low cost may have been purchased locally where there was little market for walnut and was probably low-grade material. That employed in ship and boat building at an unusually high cost was doubtless selected figured wood for inside-finish work.

AIRPLANES.

Black walnut is valued highly for airplane propellers chiefly because of its excellent seasoning and working properties and also because it possesses strength without excessive weight. Some authorities claim that black walnut is by far the best wood for this pur-

pose. Ash, mahogany, oak, and some other woods are used for these propellers at the present time in the United States. The propeller blades are built up of several plies of wood glued together. Extreme care must be taken in making propellers, for any slight warping or opening of a glued joint may render the propeller worthless. Propeller stock should be seasoned by special methods, and the different laminations should be approximately of the same density and the same moisture content. The laminations are kept under constant moisture conditions for several days prior to gluing. Propellers are first finished to the exact form and afterward are balanced. The ends of the blades are often tipped with a strip of sheet copper, and the propeller is covered with varnish or some other preparation to protect the wood. Walnut for airplane stock must be of the highest grade and entirely clear. Wide lumber, usually 1 inch thick, is demanded. Statistics are not available on the amounts of black walnut consumed in the industry or on the average prices paid for what was used. The United States, through the Bureau of Aircraft Production, paid during the war as much as $310 a thousand board feet for black-walnut propeller stock, and this was considered a very high price at that time.

EXPORT.

Exportation has always played an important part in the walnut-lumber industry. European countries early recognized the value of the timber, particularly for cabinetwork. It is claimed that black-walnut timber was shipped to Europe as early as 1629. War conditions have interfered with its exportation during the past few years. During the year 1918 its shipment from the United States in the form of the log and for any but war uses was stopped, and, on account of the disturbed conditions abroad, exportation is still considered below normal. However, the amounts exported are now steadily increasing.

Walnut is exported in the form of both logs and lumber. Table 24 gives the amounts of logs and the total and average values for different years, by countries. Similar data are not available for lumber. Records of walnut-lumber exports for the year 1912 show that approximately 75 per cent of the total lumber output of the large walnut producers was exported during that year. According to the calculated amounts shown in the section on "Demand" this exportation amounted to about 31 million feet, which would be distributed about as follows: Germany, 50 per cent, 15.5 million board feet; British Isles, 35 per cent, 10.85 million board feet; other countries (principally Denmark, Scandinavia, Holland, Belgium, and Spain), 15 per cent, 4.65 million board feet. During the first six months of

1919 only about 25 per cent of the total lumber output was exported, and about 95 per cent of this went to the British Isles and to parts of Denmark and Sweden. The greatest demand for both logs and lumber before this had been from Germany. There is little demand from either France or Italy. According to these data the total exportation of walnut logs and lumber in 1912 amounted to about 43 million board feet, lumber measure.

TABLE 24.—*Amounts and values of walnut logs exported from the United States during the fiscal years ending June 30, 1912 to 1917.*[1]

Country.	1912		1913		1914		1915		1916		1917	
	1,000 board feet.	Value per 1,000 board feet.	1,000 board feet.	Value per 1,000 board feet.	1,000 board feet.	Value per 1,000 board feet.	1,000 board feet.	Value per 1,000 board feet.	1,000 board feet.	Value per 1,000 board feet.	1,000 board feet.	Value per 1,000 board feet.
Total	9,816	$62.35	12,711	$54.49	6,951	$54.96	1,090	$71.87	1,083	$81.49	1,604	$104.33
Europe:												
Austria-Hungary	4	59.25										
Belgium	791	71.30	395	54.98	509	55.43	15	56.67				
Denmark	19	49.47	12	37.50								
France	77	60.39	416	87.59	672	28.47	105	67.82	22	77.45		
Germany	7,759	61.52	10,307	52.15	4,535	57.09	209	62.89				
Netherlands	140	78.64	161	72.90	144	69.74			9	66.67		
Portugal	9	133.33	11	81.82	6	80.33			5	45.00		
Spain			4	111.25	39	61.00						
Sweden									144	73.64		
United Kingdom:												
England	964	57.81	1,213	57.98	847	59.72	720	74.32	825	85.93	1,209	106.64
Scotland	41	69.15	84	67.08	120	60.33	37	94.59	19	54.79	382	97.97
Ireland	10	80.00										
North America:												
Canada	2	78.50	72	72.18	60	65.80	4	53.75	56	55.18	11	76.27
Mexico			34	60.29								
Central America: Panama									3	33.67		
Africa: British South			2	104.00	19	60.53					2	77.50

[1] None exported for the year 1918.

Data are not available on the export of walnut veneer. It is said that foreign countries generally manufacture their own veneer from the logs. On account of the extensive use of carved work thin lumber five-eighths and three-fourths inch thick largely takes the place of veneer in Europe.

Walnut logs have always been in great demand from foreign countries, especially from Germany. There is hardly any section throughout the walnut area of the United States from which the choice walnut timber has not been taken, often hauled long distances, and shipped to Germany, usually to Hamburg. Thence it was redistributed in the form of logs, veneer, or lumber, largely to Russia, Poland, Austria, and Scandinavia. This timber was used chiefly for furniture, walnut furniture being well liked in those countries. A large part of the shipments to England also was reshipped to Germany. Canada, Mexico, South America, and South Africa are promising markets for this timber.

There has always been a big foreign demand for such walnut-finished articles as sewing machines and music cabinets. Many firms depended upon the export trade almost entirely to take their walnut-finished products. Formerly the dark-finished walnut of uniform shade was in demand, but now the foreign trade prefers the more natural color of the wood. The plain heartwood finished in a brown natural color is now well liked.

WAR-TIME UTILIZATION.

Two products made from walnut are used in warfare—airplane propellers and gunstocks. To obtain maximum production, both propeller and gunstock material should be cut, so far as possible, from the same log. High-grade stock, 1 inch in thickness, is required for propellers; and it should be 8 inches wide and over and 8 feet long and over, although a specified maximum proportion of the lesser widths and lengths is allowed. The propeller grade is about equivalent to firsts and seconds, but will include some of the large-sized pieces of No. 1 common. Gunstock material is sawed from the log in the form of flitches—that is, without the bark being edged off—and low-grade flitches may be used. Any piece is of value that will yield a gunstock blank free from all defects, including both cross grain and pith, the latter being called "heart." The flitches are 2½ inches in thickness.

Small and defective logs do not usually yield propeller stock, but are sawed entirely into flitches. Large and mostly clear logs usually yield a high percentage of propeller lumber. Because walnut logs are apt to be defective near the center, the propeller lumber is usually sawed from near the outside of smooth logs; if serious defects are encountered, gunstock flitches are cut.

Straight-grained material is particularly in demand for propeller laminations, and is more often obtained by sawing tapered logs with the grain—that is, in a line approximately parallel to the bark rather than to the central axis of the log. This generally leaves a wedge-shaped piece in the center, but does not increase the amount of waste, as logs from which propeller stock is cut are more liable to be defective toward the center.

Some gunstock material is obtained even from practically clear logs in sawing on two parallel sides. By sawing from four sides of the log a larger yield of propeller lumber may be obtained from high-grade logs than from sawing from two parallel sides. This method, however, reduces the yield of gunstock material, increases the proportion of waste, and makes narrower propeller stock. During the late war, manufacturers were required by regulations of the War Department to saw the logs with all cuts parallel, in order that the propeller

lumber might be of full width and the gunstock flitch might not be edged. This was a great advantage in cutting out the clear blanks.

Some mills found it possible to saw as much as 40 per cent of propeller stock from their logs. This was generally accomplished by sawing on four sides of the log. The small amount of gunstock flitch obtained by this method was very defective and yielded few blanks; hence the resultant waste, including low-grade lumber unsuited for war material, amounted to about 50 per cent. When the best utilization was reached in the production of war materials, the average yield was about as follows: Propeller lumber, 15 to 18 per cent; gunstock flitch, 65 to 70 per cent; waste, in the form of low-grade lumber, 15 to 18 per cent.

TABLE 25.—*Proportionate amounts of propeller stock, gunstock flitch, and low-grade lumber; and values per 1,000 board feet, sawed from walnut logs.*

TYPE 1.—FAIRLY SMOOTH LOG, 15 INCHES IN DIAMETER ("GUNSTOCK LOG").

[In cases A, B, C, and D all cuts are parallel.]

Case.	Propeller stock.			Gunstock flitch.			Low-grade lumber.			Total value per 1,000 feet.
	Per cent.	Amount.	Value ($300 per 1,000 feet).	Per cent.	Amount.	Value ($1 per gunstock blank).	Per cent.	Amount.	Value ($20 per 1,000 feet).	
		Feet.						*Feet.*		
A	.....	.....	.....	85	850 feet, at $143 per 1,000 feet (7 feet per blank).	$121.55	15	150	$3.00	$124.55
B	10	100	$30.00	70	700 feet, at $111 per 1,000 feet (9 feet per blank).	77.70	20	200	4.00	111.70
C	15	150	45.00	60	600 feet, at $100 per 1,000 feet (10 feet per blank).	60.00	25	250	5.00	110.00
D	25	250	75.00	20	200 feet, at $67 per 1,000 feet (15 feet per blank).	13.40	55	550	11.00	99.40

TYPE 2.—SMOOTH LOG, 18 INCHES IN DIAMETER ("PROPELLER LOG").

[In cases E and F all cuts are parallel. In case G the log is cut on all four sides.]

E	50	500	$150.00	45	450 feet, at $111 per 1,000 feet (9 feet per blank).	$49.95	5	50	$1.00	$200.95
F	60	600	180.00	30	300 feet, at $100 per 1,000 feet (10 feet per blank).	30.00	10	100	2.00	212.00
G	75	750	225.00	10	100 feet, at $80 per 1,000 feet (12 feet per blank).	8.00	15	150	3.00	236.00

During the war period logs were divided roughly into two classes—airplane logs, which would saw out comparatively large amounts of propeller stock, and gunstock logs, which were of value chiefly for the gunstock flitch. When the best utilization was practiced smooth logs 16 inches and over in diameter at the small end were generally considered as airplane logs, and rough logs of all sizes and smooth logs under 16 inches in diameter at the small end were classed as gunstock logs. Some flitch was, of course, obtained from propeller

logs, and a small percentage of propeller stock was sawed from the better grade of gunstock logs.

If a fairly smooth log 15 inches in diameter is regarded as typical of gunstock logs as a class, the manufacturer could obtain stock in about the proportions and amounts and at the values given under Type 1 in Table 25. Naturally, the smaller the proportion of propeller lumber sawed, the larger the proportion of flitch and the better its quality. The better the quality of the flitch, the smaller will be the number of board feet required to produce a gunstock blank, because of the smaller amount of waste. If a smooth log 18 inches in diameter is taken as representative of the propeller-log class, proportions and values would be those given under Type 2 in Table 20. It was, therefore, more profitable to cut a high percentage of gunstock flitch from the gunstock logs than to saw the maximum amount of high-priced propeller stock from them with the large amount of low-grade lumber that would also be produced. From propeller logs the greatest profit could be obtained by sawing the maximum amount of propeller stock, notwithstanding the greater proportion of low-grade material produced. A yield of as much as 75 per cent of propeller stock could ordinarily be obtained only by sawing on four sides of such logs.

Many small mills sawed only inch lumber from walnut logs. This lumber was generally purchased by other firms and the propeller grade sorted out. This practice resulted in much waste of war material. Mills were later required to saw gunstock flitch along with the propeller stock in order to effect better utilization.

Two types of United States Army rifle stocks were made during the war—the Enfield, which was made in by far the largest quantities, and is a modification of a new model British Army rifle; and the Springfield, which is slightly shorter and smaller than the Enfield, and is the older United States Army model. Large amounts of British Army stocks were made of American black walnut. Fortunately, the model commonly used by the British Army is a two-piece stock made up of a "butt" and a "fore end." These parts were manufactured from the pieces of flitch left after cutting out the one-piece United States Army rifle blank. Smaller pieces called "hand guards," which go over the barrel of the rifle and protect the hand from the heat of the barrel, were also made from the waste walnut.

Statistics compiled by the War Industries Board show that the following amounts of black-walnut timber were used by the United States and the Allies during the late war: For airplanes, 9.609 million board feet; for gunstocks, 94.832 million board feet; total, 104.441 million board feet. In explanation, it may be well to state

that a certain portion of this material was manufactured into the finished product outside of the United States.

During the war very high prices were paid by the Bureau of Aircraft Production for propeller stock, amounting to as much as $310 a thousand board feet for walnut. The contract price for walnut gunstock blanks was about $1 a blank, amounting to about $120 a thousand board feet for the flitch material.

SUMMARY OF GENERAL MARKET CONDITIONS.

On account of the scarcity and high cost of walnut logs they are generally utilized very closely. The great bulk of the walnut is handled at large mills that are equipped for the manufacture of both lumber and veneer. Band saws, experienced sawyers, and modern kilns contribute to make a very efficient utilization. In veneer manufacture 20 square feet of veneer are obtained to each board foot, log scale, of logs, and in the making up of panel stock about one-half of this is wasted. There is a waste of about 25 per cent also in manufacturing furniture from the lumber. Allowing a 20 per cent overrun of the log scale in the manufacture of lumber, we have the yields shown in Table 26 from 100 board feet of lumber, log scale:

TABLE 26.

	Original log scale.	Total product.	Net amount used in finished product.
Lumber	100 board feet	120 square feet, 1 inch thick	90 square feet, 1 inch thick.
Veneer	do	2,000 square feet veneer, $\frac{1}{28}$ inch thick.	1,000 square feet (finished panel).

There is evidently a great economy in using veneer in place of lumber; moreover, a much better, more attractive, and more durable piece of furniture may be made by the use of veneer.

The principal problem of the walnut manufacturer is the disposal of his low-grade stock, both of lumber and veneer. It is most profitable for him to turn his large, clear, and especially his figured logs into veneer; for, although the lumber sawed from such logs may bring a high price, the veneer sliced from them will bring much more. However, if only small and defective logs are converted into lumber, only low-grade stock will be obtained, and this is difficult to market. The stocks of walnut veneer were greatly reduced because of the discontinuation of the making of veneer during the war. For this reason comparatively small amounts of the highest grades of lumber are being manufactured, and furniture factories are using more of the lower-grade stock.

Many sawmills find it profitable to cut low-grade lumber into furniture dimension stock. Many furniture factories, however, object to using dimension stock because the quality is not good enough, or the sizes are not exactly suited to their needs. They prefer to buy the lumber and cut their stock sizes from that. It is, of course, more expensive to ship the lumber than the dimension sizes cut from it. Sawmills should be able to saw the stock sizes more cheaply than the factory can; but if there is considerable waste in the use of dimension stock it is more profitable to buy the lumber. The sawmills can often recut their low-grade walnut lumber into a special grade of stock for furniture, and therefore it is not necessary for the factories to handle so much waste material. This is also more economical for the factories than cutting clear stock from very defective lumber. A large surplus of very low-grade stock and of small clear pieces accumulated from the manufacture of walnut war material is now in the hands of the large walnut operators. This stock is absorbed very slowly. Since only small dimension pieces can be made from this stock, markets for this material are very limited, and a great deal of it goes into the waste pile and is used for fuel.

The more extensive use of walnut instead of the various woods now substituted for it in making the small solid parts of walnut furniture would effect a closer utilization of the wood. These small pieces should be sawed from low-grade stock, of which there is usually a surplus in the hands of lumber manufacturers.

The small demand for low-grade walnut veneer makes the waste in veneer manufacture greater than it would otherwise be. This low-grade veneer is suitable for backings and drawer bottoms, but factories prefer large sheets from a lower-priced wood, because there is less trouble in cutting out the required sizes. Under present conditions a large part of the sapwood and defective veneer must be used for fuel.

MARKETING WALNUT TIMBER.

Owners of standing walnut timber generally dispose of their trees through a log buyer, who may be either an independent buyer or regularly employed by a walnut-manufacturing concern. Professional log buyers generally have connections or arrangements with some establishment for reselling the timber. Because, as a general thing, the occurrence of the tree is occasional, walnut is often handled by small log buyers, who may dispose of it to a larger log buyer. Small country sawmill owners often purchase walnut logs and sell them, or at least the choice ones, to a large mill or factory. As the timber passes through the hands of several men before reaching the mill, the original owner may get comparatively little for it. Some

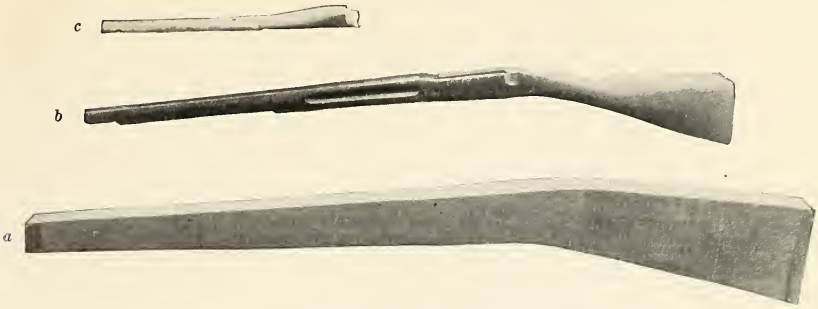


FIG. 1.—STOCK OF A UNITED STATES ARMY RIFLE.

a, blank; b, finished stock; c, front hand guard.

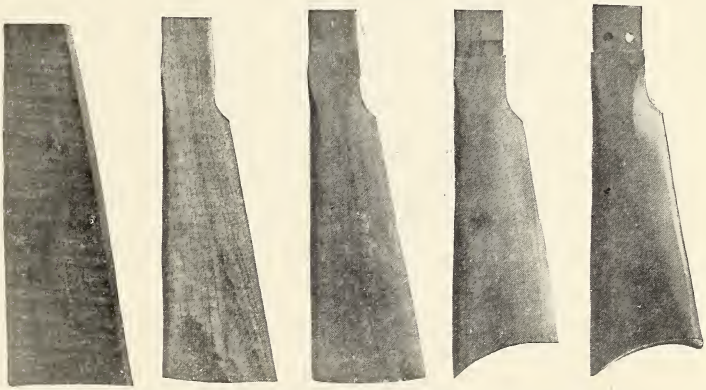


FIG. 2.—EVOLUTION OF AN AIR-RIFLE STOCK FROM THE PLAIN BLANK TO THE FINISHED STOCK.

FIG. 3.—EVOLUTION OF A SHOTGUN BUTT FROM THE ROUGH BLANK TO THE FINISHED STOCK.

These butts are sometimes made from waste rotary veneer cores.

FIG. 1.—WALNUT LOGS SUITABLE FOR LUMBER AND VENEER.

FIG. 2.—WALNUT VENEER LOGS OF GOOD SIZE AND QUALITY.

Well shaped, with small amounts of sapwood, and nearly clear of large defects.

FIG. 1.—WALNUT STUMPS FOR SLICING INTO FIGURED "BUTT" WOOD VENEERS.

FIG. 2.—WALNUT VENEER LOGS.

The two small logs near the top, although only 13 and 14 inches in diameter, are suitable for making veneer because the rim of sapwood in each is less than one inch in thickness.

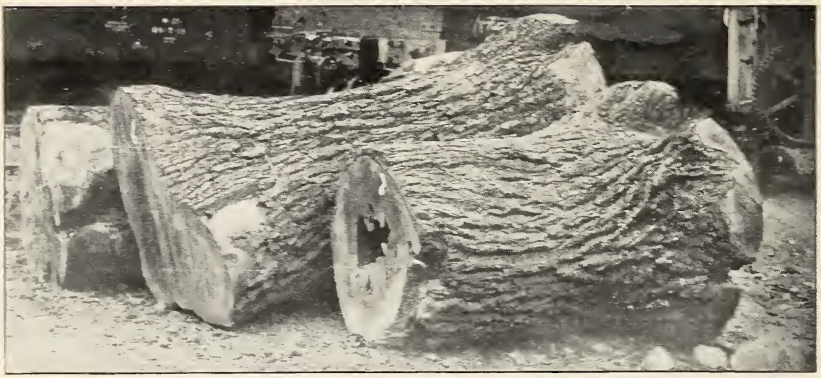


FIG. 1.—TWO WALNUT STUMPS WITH ROOTS PROPERLY TRIMMED OFF FOR MAKING VENEER.

The longer stump is 7 feet in length, with a crotch at the top end, and is particularly valuable for veneer.

FIG. 2.—A 12-FOOT WALNUT LOG (THE LARGE ONE IN THE FOREGROUND) THAT SHOULD HAVE BEEN CUT TO 10 FEET IN LENGTH.

If a portion had been sawed from each end it would have scaled as a 16-inch log, and the general quality would have been much higher.

FIG. 3.—A VERY DEFECTIVE KNOTTY WALNUT LOG.

Scarcely worth sawing into lumber and worthless for veneer. The defectiveness of this log is indicated by the large knots visible on the surface, which have not healed over smoothly.

manufacturers prefer to buy their walnut logs through dealers only, rather than to purchase in small lots from owners. This is particularly true of firms that make a specialty of figured walnut veneer. Other manufacturers prefer to buy from the owners of the standing timber through their salaried log buyers. A few firms buy walnut logs subject to inspection at the mill.

Walnut trees are usually converted into logs for the manufacture of either lumber or veneer, because of the comparatively high value of walnut in these forms. (Pl. XII, fig. 1.) Conversion into ties, fence posts, and fuel wood, except in regions far removed from the railroad, is confined to that part of the tree which is too small or defective for lumber or veneer. Large and figured logs may be hauled and shipped long distances at a profit. (Pl. XII, fig. 2.)

Formerly choice walnut timber for export was purchased from remote mountainous sections of the eastern United States, where a good supply was found, and hauled 25 or 30 miles over rough mountain roads to the railroad for shipment to the coast. During the war walnut timber was hauled as far as 20 miles to the railroad in sections west of the Mississippi, where there were comparatively large stands.

Walnut butts or stumps are very valuable if they are highly figured. (Pl. XIII, fig. 1.) If they are plain they do not have special value. The figured portion should be at least 28 or 30 inches in length. Burls are very rare and bring high prices at veneer plants. These burls have the appearance of a knot, and typical specimens are covered with little conical spines. They are more often found near the outer western limits of the area of distribution, where the trees are apt to be stunted and not thrifty. As a general thing, only those burls at the stump or root of the tree, called root burls, and mostly beneath the surface of the ground, are of value; those higher up on the trunk or on large limbs are generally full of cavities. A good burl should have sound, solid wood like the normal growth. The best burls are usually turnip shaped.

It is impossible to give current prices for walnut logs, both because there has been a great fluctuation in price on account of the war's demand, and because walnut mills do not generally put out a price list, the amount paid being determined by the quality of the individual logs, particularly in regard to their suitability for veneer. During the war, prices ranging from $20 to $120 a thousand board feet, log scale, were paid for standing timber, depending on size and location. This averaged about $50 a thousand. The prices for logs on board cars at the railroad ranged from $45 to $150 a thousand for diameters 12 inches and over, making in most cases a cost for all sizes of $100 to $110 a thousand at the mill. The average-sized log

measured between 15 and 16 inches, and low-grade logs were included if they were not too defective. Comparatively little standing walnut timber was purchased for a short time after the close of hostilities, because of the large stocks on hand at the time of the signing of the armistice.

Prices of $75 to $175 a thousand board feet at the mill were reported soon after the close of the war, $75 representing the price for 16-inch logs, and the average cost for logs of all sizes being about $90 a thousand. The higher prices were for large veneer logs of special value. If $50 a thousand is allowed for logging and freight costs, the variation of stumpage prices is from $25 to $125 a thousand for logs 16 inches and over, or an average price of about $40 a thousand, this average price applying to a log about 19 inches in diameter. These prices are given only for the purpose of indicating the variation. They vary greatly with the quality of the timber and the distance from market. While the prices paid shortly after the war were slightly higher than those paid during the war, the quality of the logs was much better. the prices applying to logs that were comparatively clear. War-time costs of 16-inch logs at the mill amounted to about $110 a thousand on the average, while $75 a thousand was paid more recently for logs of the same size and of better quality. During the first half of the year 1920 prices for walnut and other hardwoods were very high. Prices paid in Indiana for walnut logs at the mill in some cases averaged about $300 a thousand board feet, log scale, and large, high-quality veneer logs brought about $500 a thousand board feet at the mill. Whether high prices will prevail depends for a large part on future prices of walnut lumber and on prices of other hardwoods. The very high cost of marketing timber is one of the main factors responsible for these greatly increased prices at the mill. Highly figured wood, including stumps, crotches, and burls, is worth more than the average veneer log, the value depending on the size and quality of log and the kind of figure. Burls are sold by weight, usually for 10 or 15 cents a pound and up.

If the farmer has walnut trees which he wishes to dispose of, it is generally more profitable for him to fell the timber and haul it to the railroad than to sell it on the stump. After the timber is sawed into log lengths its actual worth may be better judged than when it is in the standing tree. Firms often buy standing timber by paying a lump sum for the lot. It is generally more satisfactory, however, to sell in conformity with a scale of prices, by the thousand board feet, according to the size of logs. The size is generally determined by the average of two diameters taken at right angles to each other and measured inside the bark at the small end. A 14-inch log is usually the minimum size desired; however, 12-inch logs are taken if

they are straight and first class in every way. Small figured logs also are in demand. Trees should be felled by cutting as near the ground as possible if the wood is sound, in order to get the advantage of the extra length of large-sized material.

The usual merchantable lengths are 8, 10, 12, 14, and 16 feet. An allowance of at least 2 inches over these lengths should be made for trimming the lumber at the mill. Some firms allow odd lengths; some allow only certain proportions of lengths under 10 and under 12 feet. Shorter lengths than 8 feet may be allowed when it is necessary to cut the log short, if it is large and of good quality, and especially if it is a figured or otherwise high-grade veneer log. Veneer logs 6 feet or even 4½ feet in length are accepted by some mills.

Unless they are very large, logs for veneer manufacture preferably should not have more than a 1-inch rim of sapwood. (Pl. XIII, fig. 2.) Three and even 2 inches of sapwood spoils the ordinary-sized log for veneer. Open-growth timber often has much sapwood. If there is a good amount of heartwood, and if it is not too defective, this timber is often very valuable for veneer on account of the figure that is generally present.

Figured logs are now greatly in demand. Highly figured stump or "butt" wood is especially valuable. However, few stumps have the valuable wrinkle, curl, or roll figure. This figure is generally evidenced by a ridged surface under the bark. Panel lengths are 30 and 36 inches, and, if the figure extends over this entire length, the log is of much value. Stump wood, to be marketable, should be at least 20 inches in diameter at the small end and from 30 to 42 inches long. Only the solid portion of the stump can be used, and the base should be squared off by sawing. The root spurs along the side of the stump should be cut off nearly flush with the surface of the trunk. (Pl. XIV, fig. 1.) The roots are sometimes used for hatracks and coat racks, for hall trees, and for couch legs. Crotches are often of value and should be cut about the same length as stump wood.

Walnut logs are usually measured by the Doyle log rule. Table 27 gives the number of board feet in logs of different diameters and lengths. Careful attention should be given to cutting the logs into the most advantageous lengths. If it is practicable, logs should be cut at a crook, crotch, or knot, in order to get as straight and clear lengths as possible. (Pl. XIV, fig. 2.) The amount of scale obtained and the price may vary with the method of cutting. For instance, a log cut 16 feet long, having a diameter of 14 inches, and containing 100 board feet, on account of a marked taper in the upper 2 feet, might measure 16 inches at a length of 14 feet. This would give a scale of 126 board feet (over one-fourth more) at a price of, perhaps, $10 a thousand more, on account of the greater diameter. This does not mean that there is necessarily an advantage in cutting short

log lengths, for some log buyers take the diameter measure of long logs at some specified distance back from the small end. If, however, there is a decided taper at the upper end of the merchantable length of the tree, it would often be a loss to the owner to leave that small-diameter material on the log. Defective parts of the bole may often be left out altogether to better the quality of the logs. (Pl. XIV, fig. 3.) After the trees are cut the logs should not be left lying for a long time on the ground or exposed to the sun. The logs should be raised from the ground and the ends should be painted. If the ends of the logs are checked at the time of felling, it is customary for the cutters to make a blunt cut with a wedge across each end of the check. This helps to prevent the check from extending to the bark and, what would often result, the log splitting open its entire width.

TABLE 27.—*Amounts of board feet, log scale, contained in logs of different lengths and diameters, measured according to the Doyle log rule.*

Diameter, small end inside bark (inches).	Length in feet.										
	6	7	8	9	10	11	12	13	14	15	16
	Board feet.										
6	1	2	2	2	2	3	3	3	3	4	4
7	3	4	4	5	5	6	7	7	8	8	9
8	6	7	8	9	10	11	12	13	14	15	16
9	9	11	12	14	16	17	19	20	22	23	25
10	13	16	18	20	22	25	27	29	31	34	36
11	18	21	24	28	31	34	37	40	43	46	49
12	24	28	32	36	40	44	48	52	56	60	64
13	30	35	40	46	51	56	61	66	71	76	81
14	37	44	50	56	62	69	75	81	87	94	100
15	45	53	60	68	76	83	91	98	106	113	121
16	54	63	72	81	90	99	108	117	126	135	144
17	63	74	84	95	106	116	127	137	148	158	169
18	73	86	98	110	122	135	147	159	171	184	196
19	84	98	112	127	141	155	169	183	197	211	225
20	96	112	128	144	160	176	192	208	224	240	256
21	108	126	144	163	181	199	217	235	253	271	289
22	121	142	162	182	202	223	243	263	283	304	324
23	135	158	180	203	226	248	271	293	316	338	361
24	150	175	200	225	250	275	300	325	350	375	400
25	165	193	220	248	276	303	331	358	386	413	441
26	181	212	242	272	302	333	363	393	423	454	484
27	198	231	264	298	331	364	397	430	463	496	529
28	216	252	288	324	360	396	432	468	504	540	576
29	234	273	312	352	391	430	469	508	547	586	625
30	253	296	338	380	422	465	507	549	591	634	676

Costs of marketing include those of buying the timber, felling the trees, cutting into lengths, hauling to the railroad, loading on cars, and transporting to market. Buying costs generally range from $5 to $10 a thousand board feet. The cost of felling is variable, depending mostly on the extent to which the timber is scattered. If the trees are frequent, the cost of felling and sawing into logs generally varies from $2 to $5 a thousand; if the growth is much scattered, and if considerable time is lost in going from one tree to another, the cost may amount to several dollars a thousand more. The cost of

hauling and loading on cars varies almost directly with the distance; it usually runs from $15 to $30 a thousand for a 5 to 10 mile haul. The freight cost depends, of course, on the distance to the mill or factory.

Farmers owning walnut timber usually find it profitable themselves to haul their logs to the railroad, especially during the winter months, when work is comparatively slack. The timber is not so apt to deteriorate at this time of the year, and hauling may then be done more conveniently. Inspection may be made by the buyer's representative at the farm, the railroad, or the mill. If the logs are of average size and quality the mills will purchase as little as 3,000 board feet, log scale—an amount which is considered a minimum carload. Smaller shipments are often made if the logs are very high grade or figured. Owners of small lots of timber may often combine to ship a carload. Following are the shipping weights of walnut in various forms:

	Pounds.
Rough lumber, 1 inch thick, 1,000 board feet, green	[1] 4,900
Rough lumber, 1 inch thick, 1,000 board feet, dry	[1] 3,800
Logs, 1,000 board feet, log scale, Doyle rule:	
Diameter, inside bark at small end, 12 inches, green	11,900
Diameter, inside bark at small end, 12 inches, dry	8,200
Diameter, inside bark at small end, 18 inches, green	8,300
Diameter, inside bark at small end, 18 inches, dry	5,700
Diameter, inside bark at small end, 24 inches, green	7,100
Diameter, inside bark at small end, 24 inches, dry	4,900
Cordwood, bolts, butts, etc., 1 cord of 128 cubic feet, green	[2] 4,700
Cordwood, bolts, butts, etc., 1 cord of 128 cubic feet, dry	[2] 3,200

SUMMARY AND CONCLUSIONS.

The use of black walnut covers as long a period as that of any other native wood. It has been repeatedly predicted that the supply would soon be exhausted. The timber has never been plentiful; but, on account of its being scattered throughout a large area, there has been a fairly steady supply since colonial times. Its area of commercial distribution is, roughly, the eastern half of the United States exclusive of the coastal regions, the southern Mississippi Valley region, and the extreme northern regions. The principal supplies are now located in central Tennessee, eastern Kentucky, northwestern West Virginia, Ohio, Indiana, Illinois, southern Iowa, Missouri, southeastern Nebraska, eastern Kansas and Oklahoma, northeastern Texas, and northwestern Arkansas. Although the best quality of walnut has come from Ohio and Indiana, the general run of the timber is now better in the western part of its range, because it has not been

[1] Official standard weights of the National Hardwood Lumber Association.
[2] Figured on the basis of 90 cubic feet of solid wood content.

cut out to the extent to which it has in the eastern part. The best stands are now west of the Mississippi River.

Before the war the annual demand amounted to about 60 million board feet; during the war it increased to about 90 million board feet. A large part of the total is exported in normal times, principally to European countries.

The greatest problem of the lumber manufacturer is to dispose of his lower grades, of which there was a surplus from the manufacture of high-grade airplane-propeller lumber during the war. The cutting of dimension stock is often impracticable, on account of the varying needs of the factories using this stock. It is now a common practice among walnut-lumber manufacturers to recut low-grade stock in order that it may be classed in a higher grade, or may be sold as a special grade of small-dimension stock of a better kind.

Walnut is valued mainly for its good seasoning, working, and gluing qualities, its fine appearance, and its good finishing properties. Its principal uses are for cabinetwork in furniture, musical instruments, and sewing machines, for interior finish, and for gunstocks. For cabinetwork and inside finish it is used very largely in the form of veneer panels. Thin lumber is used extensively in European countries for cabinetwork, instead of veneer. Other cabinet woods—as, for instance, red gum and birch—are commonly used for the solid pieces in cabinetwork. A substitution, however, detracts from the appearance and general quality of the piece. Panels are usually made of five plies, and the outer ply is generally of the striped walnut that is characteristic of open-growth trees, or of some other highly figured walnut as, for example, cross figure, stump wood, crotches, or burls.

There has been a recent revival in the popularity of black walnut furniture, which is now given lighter finishes more nearly like the natural color of the wood. This treatment brings out the natural beauty of the grain and figure. For this reason the rapid-growth, light-colored heartwood is now more in demand than is the dark, uniformly colored. Figured wood is scarce and highly valued, and is cut into veneer usually one twenty-eighth inch in thickness.

Walnut veneer is cut by the straight rotary, stay-log rotary, or straight-slice process. Manufacturers get about 20 square feet of veneer from each board foot of logs, log scale, with a waste of about 55 per cent. This waste is unavoidable, and includes the sapwood, the defective veneer which is not marketable, the wood trimmed off before a sheet of merchantable width is obtained, the waste due to defects, and the "dog board." Because walnut veneer logs run comparatively small in size, wide walnut veneer is much in demand.

Walnut is a suitable wood for railway ties, fence posts, and firewood, but only small and defective material is ordinarily converted into these products.

The price of walnut lumber has increased greatly during recent years, and the same thing is true of the price of such other cabinet woods as red gum, white oak, and birch. These prices have also effected a great increase in the price of logs. During the war, on account of the unprecedented demand for walnut, much small and defective material was accepted. Logs 14 inches and over in diameter and at least fairly clear are now generally specified. The increased expense of logging and of freight has been an added factor in making the cost of logs higher than before the war.

Owners of walnut timber can dispose of their trees to best advantage to walnut lumber and veneer manufacturers, and to factories that purchase walnut in the log form. Figured walnut is more valuable than plain. Walnut firms do not, as a rule, publish a fixed scale of prices and log grades, the price generally being set by the log buyer.

Although the present very high market price of the timber may not be maintained, walnut will always be in demand, and will bring good prices because of the intrinsic value of the wood. Owners of timber tracts containing walnut will generally find it profitable to favor the young growth of this timber over that of less valuable species.

APPENDIX.

DETAILED LIST OF USES OF BLACK WALNUT REPORTED BY FACTORIES.

Boxes and crates.—Ballot boxes; lodge ballot boxes; box handles; machine boxes; seed boxes; storage battery boxes; tool boxes; tool chests.

Brooms and carpet sweepers.—Carpet sweepers.

Bungs and faucets.—Bungs.

Car construction.—Cabinetwork (electric cars); cabinetwork (passenger cars); car repairing; cars (finish); cars (interior finish); passenger cars; passenger cars (interior finish); railroad cars; switch-box covers (Pullman cars); upper berth doors (sleeping cars); grilles (Pullman cars); panel wainscoting (Pullman cars); push buttons (Pullman cars); sash (Pullman cars).

Caskets and coffins.—Casket cases; caskets; coffin cases; coffins.

Chairs.—Chair arms; chair arms (Pullman cars); chair-back posts; chair legs; chairs; desk chairs; ecclesiastical chairs; office chairs; official chairs (lodge room); rocking chairs; chairs (spindles); rockers; parlor rockers; settees; settles.

Clocks.— Clock cases; hall-clock cases; clocks.

Firearms.—Gun butts; gun forearms; fore-end blanks; gun fore ends; air-gun stocks; air-rifle stocks; gun stocks; pistol stocks; rifle stocks.

Fixtures.—Altars; church altars; lodge altars; church Bible stands; bookshelves; cellarettes; barber chairs; closet seats; commodes; counter tops; fixtures; bank fixtures; bar fixtures; church fixtures; fixtures (exterior parts); office fixtures; store fixtures; church pews; showcases.

Frames and molding, picture.—Picture frames; picture molding.

Furniture.—Beds; folding beds (exterior parts); bedsteads (exterior); benches; bookcases; bookcases (exterior); revolving bookracks; bureaus; bureaus (exterior); cabinets; drug cabinets; filing cabinets; humidor cabinets; letter-filing cabinets; magazine cabinets; music cabinets; smoker cabinets; thread cabinets; furniture carving; carvings; case work; chests; chiffoniers; chifforobes; china closets; couch legs; desks; house desks; ladies' desks; office desks; drawer handles; dressers; dressers (exterior); princess dressers (exterior); newspaper files; foot rests; footstools; frames; mirror frames; mirror frames (Pullman cars); furniture; case-goods furniture; church furniture; lodge furniture; office furniture; hall hatracks; inlaid work; knobs; cheval mirrors; bed molding; case panels; desk panels; veneered panels; chair pillars; rails (billiard tables); rails (card tables); rails (pool tables); sideboards; chafing-dish stands; stools; tables; card tables; dining tables; drop-leaf tables; extension tables; library tables; portable lunch tables (Pullman cars); parlor tables; side tables; tea tables; taborets; veneer; wallcases.

Handles.—Handles; package handles; handles (saddlers' tools).

Instruments, musical.—Accordions; phonograph cabinets; consoles; drum shells; mandolin bodies; molding (piano players); music benches; piano music shelves; orchestrions; organ actions; pipe-organ blocks; organ cases; reed-

organ cases; pipe-organ casing; organ frames; organ parts; cabinet organs; interior organs; pipe organs; pipe organs (exterior); reed organs; reed organs (exterior); panels; piano actions; piano benches; piano cases; piano chairs; piano legs; piano molding; piano parts; piano players; piano seats; piano stools; veneer cores (piano cases); veneer cross-band work (pianos); veneer (piano cases).

Instruments, professional and scientific.—Carpenters' tools; dental cases; optical cases; embalming boards; heads (carpenters' squares); heads (draftsmen's T-squares); miter boxes.

Machine construction.—Cylinder heads; machinery construction; flour-mill machinery; flour-mill trim.

Machinery and apparatus, electrical.—Cabinets (electrical work); coil cases; electrical appliances; electrical appliances (bases): electrical equipment; telephone-subscriber sets; switchboards; telephones.

Patterns and flasks.—Patterns; foundry patterns.

Planing-mill products.—Finish; interior finish; flooring; parquetry flooring; flooring (parquetry borders); flooring strips; floors; interior trimming (house); molding; base molding (house); molding (caps, interior trim); house molding; quarter-round molding; spring-cove molding (house-interior trim); nosing (house-interior trim); panel strips (house-interior trim); panels, ceiling panels; window panels; partitions; dining-room plate rails; window aprons; window stools (house-interior trim).

Printing material.—Printers' materials.

Refrigerators and kitchen cabinets.—Kitchen cupboards.

Sash, doors, blinds, and general millwork.—Balusters; stairway balusters; baseboards; flat battens; dining-room ceiling beams; boards (fillers); brackets (plate rails); cabinetwork; cabinetwork (stairs); carpet strips; casing; door casing; head casing (house); window casing; doors; folding doors; mirror doors (house); doors (rails); sliding doors; dust caps (house-interior trim); fillet (house-interior trim); fret wood; grilles; grilles (house-interior trim); stairway hand rails; joiner work; millwork; exterior millwork; screen molding; newels; pilasters; railing; sash; door screens; fire screens; window screens; stairwork; stiles (doors); wainscot rails; wainscoting; wainscoting caps; window aprons; window stops.

Sewing machines.—Cabinets (sewing-machine); sewing-machine parts.

Ship and boat building.—Boats; interior cabinets (ship); interior cabinets (yacht); pilot wheels (ship); pilot wheels (yacht); steering wheels.

Sporting and athletic goods.—Cigar wheels (wheel of chance); tennis-racket throats; tennis rackets.

Vehicles.—Automobile bodies; automobile dashboards; automobile dashboards (fillers); automobile dash frames; automobile deck rails; automobile handrails; automobiles (interior finish); dashboards (buggy); vehicles; wind shields (automobile); window frames (automobile).

Whips, canes, and umbrella sticks.—Canes; umbrella handles.

Woodenware and novelties.—Fancy boxes; gavels; novelties; rolling-pin handles; toddy sticks; jewelry trays; serving trays; woodenware.

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